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Survey: Management of Northern Spotted Owls on National Forests and BLM Districts

Introduction

One of the Committee's charges was to "assess whether current management strategies of the agencies are reserving options that will allow for long-term strategies to conserve the northern spotted owl." in an effort to accomplish this task, and to familiarize all members of the Committee with current management strategies, we interviewed various line and staff personnel in the FS and BLM. Interviews were only one means of gaining an overview of the management situation from the perspective of some field offices of the various agencies. The survey was not intended to give the Committee a statistical sample of the agencies' current management strategies; nevertheless, the Committee individually and collectively gained important insights on the status of owl management in late 1989.

Nine National Forests and three BLM Districts were randomly selected. One Ranger District (FS) and one Resource Area (BLM) for each of the selected Forests or Districts was also randomly chosen. The NPS has jurisdiction over significant acreage of owl habitat, but was not included in these interviews because the NPS normally does not undertake activities that alter owl habitat.

Personnel interviewed were:

National Forests-Forest Supervisor, Timber Staff, and Wildlife Biologist;
Ranger Districts—District Ranger, limber Staff, and Wildlife Biologist;
BLM Districts—District Manager, Timber Staff, and Wildlife Biologist; and
Resource Areas—Area Manager, Timber Staff, and Wildlife Biologist.

Compiled analyses of the survey and specifics of methodology comprise the last section of this appendix. These results were evaluated and categorized in the following six sections to provide a summary of the findings of the Committee.

Summaries

Management Direction and Policy—Several questions assess directly or indirectly the availability and usefulness of existing policy and direction.

Findings: Differences in understanding direction and inconsistencies in implementing direction were evident throughout the interviews. Many respondents noted problems such as lack of long-term direction and "ever-changing" sets of rules. Concern was also expressed over the lack of, or inconsistencies with, short-term direction, particularly relating to timber sale activities and non-network owls (those found outside areas of protected habitat). The general sense appeared to be that the situation is so dynamic that policy is not keeping up with events.

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The expressed lack of policy was more apparent in the Pacific Southwest Region (Region 5, FS), which has less-specific and required guidance, and in the BLM, which is in the process of planning for future direction for spotted owl management and timber sales. Major differences were also noted among the FS Regions and BLM regarding standards, protocols for monitoring, and general direction.

Responses to several questions indicated significant inconsistencies between Forest and District staffs within National Forests and between District and Resource Area staff on BLM Districts. Inconsistencies were also evident among respondents on particular administrative units. Responses often indicated a lack of communication between units. High turnover rates of personnel further contribute to inconsistencies, caused by a lack of understanding of the policies and regulations and, often, by differences in interpretation of management direction.

SOHAs and Habitat Management—The objective was to assess how well agencies have followed management direction to establish SOHAs and manage for spotted owls.

Findings: In general, although a timber bias was clearly evident in the guidelines for setting up networks, management direction has been followed; much effort has been devoted to providing owl habitat. Some improvement in the efforts in the last few years was indicated, which should be commended. A few notable exceptions were observed (see Summary of Responses). Unfortunately, such exceptions create mistrust and are often the root of credibility problems that extend well beyond the specific problem or administrative unit. The exceptions point to the need for thorough and continued oversight and more standardized management direction throughout the owl's range.

Uncertainty exists, especially in the BLM and Region 5, FS, regarding the longevity of current management strategies. The interviews showed that planned silvicultural management of SOHAs has caused confusion. Whether any approved plans have been developed was unclear, and no consensus exists about whether any silvicultural systems would produce the desired results. The ability to harvest timber in currently suitable owl habitat—and have that habitat remain suitable—has not been clearly demonstrated.

The adequacy and accuracy of the data base for owl habitat is a major concern, apparently more so in the FS than in BLM. Responses indicated that data bases were not generated to identify timber stand attributes of importance for wildlife habitat, and data bases were often outdated and lacked ground-truthing.

Options to Adjust Management Strategies for the Owl—Several questions were intended to provide information about opportunities to change the amount or of management.

Findings: Current management direction in the FS is predicated on the assumption that sufficient options will exist through the next 5 to 15 years to allow adjustments in management strategy, should such adjustments be needed (adaptive management).

In general, options to adjust the SOHA networks would consist of adding acreages to SOHAs, increasing the number of SOHAs, or both. Responses indicated that options to increase the size of SOHAs exist but, in general, fewer than half could be expanded by 50 percent. This figure is particularly disconcerting because existing SOHAs, for most physiographic provinces, would need increases in the range of 20 to 60% to reach median amounts of suitable habitat in spotted owl home ranges, as described in the literature. Options to expand appear to be unevenly distributed across Forests and Ranger Districts. In areas of highest fragmentation, which are of greatest concern, SOHAs that are already the maximum size attainable are still smaller than the prescribed acreage, with no options to increase them. Responses indicate that options to increase the number of SOHAs are also limited. Here again, opportunities are not homogeneously distributed across the National Forest landscapes.

Much concern was expressed that present options for management are rapidly diminishing. Timber sales of fiscal year (FY) 1989 and scheduled for FY90 are near a high proportion of the SOHAs. Those adjacent timber stands would be the logical additions to SOHAs, if a need were identified to enlarge them. Additionally, high proportions of owl pairs outside the network are in areas with scheduled timber sales—areas that might logically become new SOHAs or that may be important in the long-term management of the owl.

Responses by the BLM mirrored concerns of the FS about their ability to increase the size, numbers, or both of BLM-ODFW agreement areas.

Responses by both agencies indicated that they have no formal policy regarding owl pairs (or individual owls) found outside the network sites, and in or adjacent to timber sales. This lack of policy requires that each case be reviewed independently. Responses further indicated that even where the sale was in the planning stage, only minor modifications were routinely made. The lack of a policy to maintain significant options around non-network pairs further erodes confidence that long-term options will exist and that opportunities to adjust management in the future will be possible. Many forest stands that may now exist as option areas are apparently being subjected to greater fragmentation. Adaptive management can work only if options are available to modify current management.

Determination of Suitable Habitat—The objective of this question was to determine the methods and information used by agencies to classify, map, and quantify owl habitat.

Findings: Concerns about the databases and ground-truthing as they relate to determining suitable habitat were expressed by many respondents (discussed earlier).

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Responses indicated serious concerns with definitions of owl habitat and suggested that further refinement of these definitions is needed. Most habitat data are still based on information collected for timber harvest. New definitions should be developed by physiographic province, describing the continuum of habitats used by the owl, and providing comments on the relative value of habitats to the owl.

Monitoring, Inventory, and Sale Surveys—The objective was to determine how agencies carry out these programs.

Findings: Responses indicated that both agencies are generally conducting monitoring programs in an acceptable manner. Concerns over funding (amounts and timing) and staffing were expressed, and indications were that some decrease in efficiency and quality resulted. Spotted owl activities often were usurping virtually all wildlife funds and personnel to the detriment of other aspects of the wildlife program.

Significant differences exist between the FS and BLM monitoring programs. Protocols for determining occupancy and reproduction are not standardized between the agencies.

Extensive efforts were made to survey all timber sales for FY89 and FY90 by both agencies. Personnel in both agencies noted that this effort was initiated across all Forests and BLM Districts for the first time last field season, mostly in response to conferences with the FWS, as indicated by Section 7 of the Endangered Species Act. For the most part, standardized direction was followed.

Questions received mixed responses on whether new data on the owl were being used to improve SOHA networks and owl management. The general feeling was that new data are being used to improve networks. Responses further indicated a desire by both agencies to "fix" management areas geographically to facilitate completion of land and resource management plans and simplify timber sale planning.

Compatibility of Owl and Timber Management Direction—This section was to provide insights into the perceptions of personnel responsible for meeting management direction for spotted owls and timber harvest targets.

Findings: Most respondents indicated a significant conflict between owl management and current timber harvest rates. A general belief that present rates of timber harvest could not be sustained was expressed by several respondents all disciplines.

Concerns were also expressed that, with the exception of one Forest, no adjustments to timber harvest have been made to account for smaller timber bases. The result was difficulty in balancing competing demands. The emphasis on owl management was believed to have negatively influenced timber programs and other wildlife programs.

Compiled Analysis of Survey: Management of Northern Spotted Owls on National Forests and BLM Districts

This report analyzes responses to a set of questions posed by Committee members and advisers to selected individuals on National Forests in Regions S and 6 and their counterparts in BLM Districts in Oregon. The objective of this survey was to assess the implementation of management direction for spotted owls in these units.

We randomly selected nine National Forests, subject to the constraint that each physiographic province would be represented in the sample in proportion to the number of Forests in each. After all Forests were drawn, we randomly selected one Ranger District on each Forest. To obtain an overview of owl management in both Forests and Districts, we interviewed the Forest Supervisor (or Deputy), a Timber Staff Officer, and the Forest Biologist on each Forest; we interviewed the District Ranger, Timber Staff Officer, and District Biologist on each District. A team of two interviewers from the Committee, together, interviewed each Forest and District person separately. We managed to complete interviews with all but two persons scheduled with the National Forest system (n = 52). When all interviews on a given Forest were completed, the Committee team then visited a few SOHAs with the District Biologist and other staff.

For interviews with the BLM, we randomly selected three Districts and then randomly selected one Resource Management Area from each District. District Managers, Timber Staff Officers, and Biologists were interviewed on each District; Resource Area Managers, Timber Staff Officers, and Biologists were interviewed on each Resource Management Area. We managed to complete interviews with all but one person scheduled with BLM (n = 17). As with the National Forests, interviewers visited a few SOMAs with the Area Biologists after interviews were completed.

We assured all persons interviewed that their responses would be anonymous. This analysis therefore does not identify any person or management unit, but represents our assessment of all responses to each question. Most questions did not permit a quantitative analysis. When reading this report, bear in mind that though “Districts” are subunits of National Forests, “Districts” in the BLM are administratively equivalent to National Forests. The BLM subunit equivalent to a National Forest District is termed a Resource Management Area.

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Following each question is a letter identifying to whom the question was addressed:

A = Forest Supervisors/District Managers, District Rangers/Resource Area Managers, Forest/District Timber Staff Officers, District/Resource Area Timber Staff Officers, Forest/District Wildlife Biologists, District/Resource Area Wildlife Biologists;

B = All of the above except Forest Supervisors/District Managers: and

C = Only Forest/District and District/Resource Area Wildlife Biologists.

Summary of Responses to Questionnaire

The SOHA Network

1. What do you consider to be the document that guides your spotted owl management activities? (A)

Forest Service:

At all organizational levels, National Forests in Region 6 generally agreed that the ROD/FSEIS provided basic guidance for owl management. Many Forests recognized the impact of the Hatfield/Adams amendment, and many anticipated using the pending Forest Plans. Forests in Region 5 responded a less certain fashion, citing the "Rainbow Book" (Regional Standards and Guidelines), FWS conferencing, and Regional Directives as guiding documents. Forests in Region 5 expressed lack of specific long-term direction; those in Region 6 seemed more comfortable with the guidance.

Bureau of Land Management:

The BLM cited the ODFW agreement, Hatfield/Adams amendment, and lawsuits as providing guidance. The BLM, like Forests in Region 5, expressed lack of specific long-term direction.

2. How many SOHAs are called for in plans for your administrative unit?

With only two exceptions, personnel on each Forest or BLM District agreed within one or two SOHAs/SOMAs to the number assigned to their unit for management. Timber-management officers were the least knowledgeable the individuals interviewed, sometimes deferring to the biologist for numb of SOHAs/SOMAs assigned. On one Forest, the number of SOHAs assigns seemed in the process of change (increasing).

3. For how many SOHAs has a general location been identified and delinea on a map? (B)

All SOHAs on FS land and ODFW agreement areas on BLM land have delineated on maps. On Districts/Forests where radio-telemetry data are available, personnel noted that use by owls may not coincide well with mapped areas "designated" for those owls.

4. Has your SOHA network been approved by the Regional Office? (A)

Both the BLM and FS expressed confidence that their "networks" met with approval of the Regional or State office. in fact, official approval of FS networks awaits final approval of Forest Plans. BLM Districts negotiated the agreement areas with ODFW.

5. For how many of these SOHAs/SOMAs have stands been mapped and acreages totaled by forest type and seral stage combinations? (B)

Forest Service:

In Region 6, essentially all SOHAs have been classified by stand as suitable, unsuitable, or marginally suitable as owl habitat. Traditional mapping by forest type and seral stage was apparently not undertaken for SOHAs, however. In Region 5, whether mapping has identified seral stage is unclear, but it has apparently identified forest type. On one Forest, the final layout of SOHAs was being reconfigured, thus precluding final mapping. Region 5 forests did not map habitat as suitable, unsuitable, or marginally suitable for spotted owls.

Bureau of Land Management:

The BLM mapped by forest type and five seral stages all ODFW-agreement areas on two Districts; the third District has completed mapping as suitable or unsuitable on about half of the agreement areas.

6. For those mapped, was mapping based on aerial photo interpretation, or ground-truthing, or a combination? (B)

Forest Service:

A combination of methods was generally used by the FS. One Forest relied primarily on aerial photo interpretation; another relied on aerial photo interpretation alone for mapping about half the SOHAs. Ave forests strongly indicated the need or desire to do more ground-truthing of mapped SOHAs.

Bureau of Land Management:

The BLM also used a combination of aerial photo interpretation, operations inventory, and ground-truthing to produce the maps of the ODFW agreement areas. The BLM was more confident than the FS that maps reflected actual conditions on the ground.

7. If not, how were they mapped? (B)

(Answers to this question are incorporated in answer to question (6)

8. How many of your SOHAs have approved management plans? (B)

Forest Service:

No Forests in Region 6 have SOHA management plans because all SOHA are reserved from entry for timber harvest. One Region 5 Forest had no SOHAs with completed plans, but another indicated about half the SOHAs had approved management plans. Many of these SOHAs are also dedicats however—that is, no timber can be harvested.

Bureau of Land Management:

No ODFW agreement areas managed by BLM have site-specific management plans; agreement areas are excluded from entry for timber harvest unless agreed to with ODFW.

9. If you have no approved plans, please explain. (B)

Forest Service:

Answers to this question were consistent within the various Forests. For Region 6 Forests, no plans are required, and all respondents knew this. For Region 5. similar consistency was evident; however, plans are a part of their direction, and responses consistently expressed an inability to make them a reality. Among reasons given for not having plans completed were lack of funds, lack of staff, too many other priorities, and an underlying suspicion that because the rules are ever-changing, no clear picture exists of what the plan should look like.

Bureau of Land Management:

For the most part, only biologists responded to this question. One stated that no plans would be done until the 1990 decadal land-use plans were completed. A second District offered that a plan on owls was attempted under the premises set forth in a 1983 land-use plan, but it was never completed.

10. How many of the SOHAs in your management unit meet acreage criteria for suitable habitat? (B)

Forest Service:

Answers to this question were inconsistent both within and among Forests. Barely half of the responses were consistent within the Forest. We assumed the Forest Biologist provided the definitive answer.

Inconsistency within a Forest was exhibited in several ways. In one instance, the District was internally consistent and so was the Forest, but the District and Forest Biologists' answers were not consistent. Sorting this out in retrospect was impossible. In another instance, answers differed at all levels. Assuming that the biologist was correct, answers from others bracketed those of the biologist.

Among Forests, inconsistency was most evident in actual number of SOHAs meeting the requirement. Answers ranged from "none" (one Forest) to "all." Only four of the nine Forests responded that all SOHAs met acreage criteria.

Bureau of Land Management:

Much variation was evident in answers within the three Districts, with nearly everyone interviewed having a different understanding or knowledge of the situation. Less variation existed in the biologists' responses among Districts than within them. Two of the three Districts recognized a goal of 2200 acres per owl pair protected, and the third specified a 2500-acre goal.

For the two Districts that reported numbers of sites meeting or exceeding the 2200-acre goal, percentages were 59 and 50. The third District offered that their agreement areas averaged 2000 acres.

11. How many of your SOHAs meet the specified habitat arrangement criteria (300-acre core area, 60-acre block sizes within a prescribed radius, in as contiguous a block as possible, and so on? (B)

Forest Service:

With one exception, answers within a given Forest were consistent. That exception was opposite opinions expressed by the District Biologist and the Forest Biologist, and explaining this difference from available information was impossible.

All criteria were met on four of the seven Forests in Region 6, with three reporting that over 95% met the criteria. For one Forest in Region 5, 75% of the SOHAs met the criteria; none did on the other Forests.

Bureau of Land Management:

Answers were consistent, in that no criteria existed or that the responders simply did not know.

12. How many of your SOHAs meet spacing requirements? (B)

Forest Service:

Answers were generally consistent both within and among Forests. Only one discrepancy occurred—between the Forest and District staffs, with the Forest Biologist presumably providing the correct answer because it verified the other responses. On one Forest, however, both the District and Forest Biologists provided information that indicated they did not understand the spacing requirements.

In all but one case, SOHAs were believed to have met spacing requirements. In one case where all SOHAs met criteria, extensions ("buds") had been added to satisfy spacing criteria.

Bureau of Land Management:

Answers indicated that no spacing requirements existed or responders did not know. Relying on the biologist's response, we concluded that specific requirements on spacing were not part of the agreement, but distribution of sites was assured during the process of building the areas.

13. Do you have other acreages adjacent to SOHA network sites that could be used to increase the amount of protected habitat within a 2.1-mile radius of SOHA centers? How many could you increase by 10%? by 25%? by 50%? (B)

Forest Service:

Biologists seemed to know most about possibilities for expanding SOHAs. In most cases, other respondents usually deferred to biologists or made estimates far different from the biologist's. Occasionally, estimates by different people were similar. Six of the nine Forests could expand acreages for all SOHAs by at least 10%. The remaining three Forests could expand most of their SOHAs by 10%.

Only two of nine Forests could expand all SOHAs by 25%. The remainder ranged from an estimated 15 to 75% of the SOHAs that could be expanded that much.

Only one Forest indicated that it could expand all SOHAs by 50%. That Forest also has the highest number of additional sites available for addition to the network. The remaining Forests indicated opportunities ranging from 0 to 75%, with most indicating about 30% of their SOHAs could be expanded by 50%.

Ranger District estimates tracked those of the Forest except where conditions precluded any increase above 10%. Thus, options may exist at the Forest scale, but in areas where the need may be greatest, few, if any, options may be available to improve SOHAs by expanding acreage.

Bureau of Land Management:

Answers varied among and within Districts. Estimates indicated that nearly all sites could be expanded by 10%; 40 to 50% could be expanded by 25%; increases of 50% were limited to less than 20% of the sites.

14. How many additional sites on your administrative area meet network criteria and could be used to add to the existing network of SOHAs? (B)

Forest Service:

Much variation existed among Forests in the number of sites available. Six of nine Forests indicated that fewer than 20 new sites could be added. One important fact emphasized by several respondents was that existing options are rapidly decreasing as timber targets are pursued. Responses indicated that few Forests had a wide option to expand on the existing network. The same situation exists with respect to increase in numbers as with size of SOHAs—opportunities differ from District to District within Forests.

Bureau of Land Management:

Estimates identified six to eight potential sites on each of two Districts. On the remaining District, although the total was unclear, a Resource Area Biologist offered that his unit might have eight to ten potential sites.

15. How many network SOHAs on your administrative unit had pair occupancy during 1, 2, or 3 of the past 3 years (base estimates on monitoring results)? (C)

This question was not interpreted uniformly and responses were therefore not comparable.

Suitable Habitat

16. What definition of "suitable" habitat has been used on your administrative area? (B)

Forest Service:

All Forests in Region 6 referred to the definition in the SF15 or, in one case, to the definition in the Regional Guide. In practice, most Forests apparently included a wide range of forest types and conditions, from young forests with inclusions of old growth to very old, multilayered stands. At least two Forests increased the elevational limits stipulated in the SEIS because they believed the limits were set too low. Forests in Region 5 indicated that they were using the "Rainbow Book."

Bureau of Land Management:

All three Districts answered that all stands at least 80 years old were considered suitable owl habitat. Beyond this, criteria did not appear to be standardized, although criteria such as “65% canopy closure” and “lots of dead and down material” were mentioned.

17. Do you feel that this definition adequately defines spotted owl habitat? (B)

Forest Service:

Almost all respondents in Region 5 said “no.” in general, they indicated that the definition was not broad enough to cover owls located in mixed-conifer/ hardwoods in California. In Region 6, most respondents said “yes” or “adequate” or “the best we’ve got.” Many reservations were expressed, however. Some believed the definition was adequate only for defining fully suitable, not for marginal habitat. One Forest considered an additional category, “candidate” habitat, that included forest stands smaller in stature and at higher elevations than limits set in the “suitable” definition.

Bureau of Land Management:

All respondents on one District were comfortable with the definition, but most biologists and some foresters on the other Districts had reservations. One Resource Area Manager believed that the definition did not match what owls were using.

18. Is the definition written down somewhere? If so, please provide a copy. (B)

Forest Service:

Forests in Region 5 had written definitions, but responses reflected a pervasive belief that definitions were inadequate because they did not cover all conditions where owls were found. in Region 6, all Forests but one had a written definition. The exception reported that they were “working on it.” Some definitions were specific, others were not.

Bureau of Land Management:

Two of the three Districts had no written definition. The third had a written definition in their 1987 Spotted Owl EA, and also said they were using the interim old-growth definition in Franklin et al. (1986. Interim definitions for old-growth Douglas-fir and mixed-conifer forests in the Pacific Northwest and California. USDA Forest Service, Pacific Northwest Research Station, Research Note PNW-447.)

19. What stand data/inventory (TRI system, photos, data, etc.) were available for delineating suitable habitat? (B)

Forest Service:

Both Forests in Region 5 reported using their timber inventory data and aerial photos. Responses among personnel were fairly consistent. All Region 6 Forests reported using a variety of resources, including TRI data, aerial photos, local knowledge of the ground, and precruise data. Most Forests relied on the TRI system and photos. Responses at all levels were largely consistent.

Bureau of Land Management:

Respondents on all Districts reported that they had used their operations inventory, aerial photos, ground-truthing, and personal knowledge of the ground.

20. How do you feel about the reliability of data used to map suitable habitat on your administrative unit? (B)

Forest Service:

In Region 5, some concern was expressed on one Forest that data were more reliable on some Districts than others. Several individuals on one Forest expressed a lack of confidence in data used to map habitat in 1986, but recent improvements in the data base had considerably reduced these concerns. Responses generally indicated that data used to map suitable habitat were reasonably reliable.

In Region 6, two of three Forests in Washington reported only moderately accurate mapping, with estimates of accuracy ranging from 50 to 90%. On the third Forest, responses indicated that mapping data were "pretty good." Much variation was seen in responses from personnel on Forests in Oregon. Concerns expressed were that the definition was too broad, that more ground-truthing was needed, that some data bases provided information only on tree species as opposed to structure, and that habitat outside SOHAs was not mapped. On two Oregon Forests, respondents indicated that they felt the mapping was only 70 to 90% accurate—within the range estimated by several people on the Washington Forests.

Bureau of Land Management:

Responses on two Districts indicated some discomfort, but respondents in all disciplines believed they had done the best they could under the circumstances. The general feeling on the third District was that mapping was only about 60 to 80% accurate.

21. On a Forest/BLM District-wide basis, how do you feel about the reliability of data used to map suitable habitat? (A)

Forest Service:

Respondents on one Forest in Region 5 were comfortable with the data. On the other, the general impression was that some Districts were in good shape, but others were not. Mapping of nonconiferous forest types was a problem mentioned repeatedly. Responses in Region 6 were highly varied. Several Forests reported accuracy in the 70 to 90% range. Two Forests did not think their data were "very good." Problems mentioned were no data on stand structure in some areas, and difficulty in mapping "marginal" habitat because nobody knew for sure what it is.

Bureau of Land Management:

Responses on all three Districts indicated a general feeling that the data were pretty good, but much opportunity remains for improvement.

22. Who determines whether a proposed timber sale is in suitable habitat? (A)

Forest Service:

With the exception of one District on one Forest, all Forests reported that District Biologists make this call, but most respondents also emphasized that the Biologist is a member of an interdisciplinary team, and that all assessments are reviewed and approved by the team. In other words, the approach is interdisciplinary. The one exception was a District where the Biologist reported, and the Ranger concurred, that the District Ranger determines suitable habitat. This determination is often counter to that made by the District Biologist.

Bureau of Land Management:

All responses indicated that Biologists are making this call. On one District, the Timber Staff assumed that all timber sales were in owl habitat, so this was not an issue.

23. Are you comfortable with the way it's being done? (A)

Forest Service:

Generally the response was "yes," but several Timber Staff voiced the opinion that the response should be more interdisciplinary. The Ranger and Biologists on one District both responded "no." In this case (referred to in response to the previous question), the Ranger and Biologist apparently did not always agree on what should be called owl habitat.

Bureau of Land Management

Biologists generally said “yes,” except that one felt that input should be solicited before timber sales were planned, not after. They did not like always being in a reactive mode. Some Timber Staff and Biologists were also a bit uncomfortable with the status quo because Biologists were having to make many judgment calls.

Evidence of Alternative Habitats

24. How many “good sites” are being excluded from the network because they do not meet the SEIS or ODFW agreement criteria? (“good” = consistent occupancy and documented reproduction). (estimate o.k.) (C)

A great deal of uncertainty was reported concerning the number of good sites that have been excluded.

Ranger Districts and Resource Area personnel consistently identified proportionately more sites than Forest or District personnel. This discrepancy could be due, in part, to uncertainty about whether sites identified in the past are still capable of supporting spotted owl pairs. Some commented that good sites do occur outside the networks, but they are being impacted by timber sale activities.

One Forest responded that no “good sites” were being excluded, but not all of their SOHAs are occupied with pairs, and good sites are known to exist adjacent to some of these SOHAs.

Biologists reported being unable to determine whether new sites were consistently occupied by reproductive pairs because thorough surveys had not been done before the 1989 field season and no previous data were available.

Some individuals indicated that, if the definition of a good site did not include consistent reproduction (often not adequately determined), additional sites exist outside the network.

25. How many others have been excluded to avoid planned timber sales? (C)

Turnover in personnel made this question difficult to answer; therefore, quantified answers were not obtained. Some responded that they were not in place at the time the networks were being planned so could not be sure if this happened. Others commented that they knew of such cases in the early years of establishing network SOHAs. Most responses indicated that, once the distribution pattern or quota for sites was achieved, the network was set. Additional sites known at the time, or sites found since, have often been impacted by planned timber sales because no real direction has been given to avoid them and Jew -options exist to harvest in other areas. Apparently, some sales planned near sites were determined by the agencies to have minimal impacts on spotted owl habitat. Planned sales were generally eliminated as the networks were developed, but sales under contract were not. SOHAs were laid out around the sales under contract.

For the BLM-ODFW sites, planned sales were agreed upon and completed, or will be completed.

Sales Activity

26. Does your unit plan to “rotate” the core area or other suitable habitat through even-aged or uneven-aged timber management? (that is, is management of your SOHAs planned?) (A)

Forest Service:

Of the nine Forests interviewed, only one indicated that SOHAs were to be managed with timber harvest allowed. Two responses indicated that some salvage was planned. A high degree of consistency was found among personnel on the administrative units and between the units on those Forests indicating that SOHAs would be dedicated.

On the Forest where management of SOHAs was planned, confusion as to whether plans were in place and whether SOHAs were to be dedicated or managed.

Bureau of Land Management:

BLM-ODFW Agreement Areas are being held in a reserve status; future management plans could change that status. One District Manager indicated that they were planning to “manage” the stands. All other responses indicated that no management was planned.

27. If so (to the above question), explain how you are confident that this can be accomplished, and provide copies of representative plans showing how you will proceed. (A)

Of those responding that some type of management was planned, primarily on one Forest, only one response indicated that written plans had been completed. No copies of plans were provided. A great deal of hope was expressed that some sorts of management strategies could be developed that would work.

28. In what proportion of your 1989 and 1990 timber sales (within the known geographic distribution of spotted owls) did you find owls when you surveyed the sale area in this or in prior years? (B)

Responses generally indicated a high proportion of timber sales with spotted owls in the vicinity (the average was 60%, median 70%, range S to 100%). These proportions were similar for both agencies. We detected some confusion as to when owls are in a sale or how close they must be to be considered affected by the sale. Actual estimates varied widely among personnel on the units and between the administrative levels of Forests and BLM Districts.

Biologists reported higher occurrences of spotted owls in timber sales than did line officers or timber managers 60% of the time, and lower occurrences of owls in sales 22% of the time. Only about 18% of the estimates agreed. A fair number of respondents (7 of 48) indicated that they did not know in what proportion of sales spotted owls were found.

Ranger Districts and Resource Areas tended to report higher percentages of timber sales with spotted owls than did Forests or BLM Districts.

29. Of sales without owls, how many times were the sites visited? (B)

Forest Service:

Most responses indicated that at least three visits were made to assess the presence or absence of spotted owls.

Bureau of Land Management:

The BLM respondents indicated no off official policy or direction for the number of visits from the State Office, leaving it to the discretion of the Districts. This lack of policy caused considerable variation.

Personnel from both BLM and FS indicated that the field season of 1989 was the first time any concerted effort was made to locate spotted owls in timber sales.

30. How many SOHAs in your unit have planned sales within a 2.1-mile radius of the nest site, center of activity, or geometric center in FY90-91? (B)

This question and question 32 were answered for FY89-90 versus 90-91. Personnel indicated that often sales were not specifically identified for FY91 or FY91 sales had been brought forward to FY90 to meet the timber volume requirements for the Hatfield/Adams Amendment.

Responses to this question varied widely among personnel within and among units. Biologists' estimates were consistently higher than those of Timber Staff or line officers. For respondents who supplied proportions (18 of 58), values ranged from 0 to 100% with a mean of 53% and a median of 59%. Nearly 30% (17 of 58) of the respondents did not know how many SOHAs had sales planned within 2.1 miles.

Appendix D: Management Survey

31. How many SOHAs are not as contiguous as they could be because of planned timber flies? (B)

Forest Service:

Responses ranged from “none” to “all,” and the question did not yield uniformly interpretable responses. Responses within and among units were highly variable, with Biologists indicating more of a problem than Timber Staff or line officers. Variability may have been due in part to differences in tenure on the unit.

Bureau of Land Management:

Most respondents agreed that this has not been a problem. SOHAs were set up under agreements with ODFW, and at that time some were impacted by sales under contract.

32. How many of your non-network pairs will have FY9O-91 sales within a 2.1-mile radius of the nest site or center or activity? (B)

(See notation for question 30).

Forest Service:

Responses, especially within Forests, were highly variable ranging from “none” to “all.” We used the Biologists’ responses as most definitive, as they routinely counted from maps; most other responses seemed to be personal estimates. Responses indicated means of about 80% of the non-network pairs in Region 5 and about 90% of the non-network pairs in Region 6 have timber sales scheduled within 2.1 miles.

Bureau of Land Management:

We found general agreement among responses from most persons interviewed that sale programs would affect a large proportion of non-network pairs. Biologists’ counts from maps indicated that 78% of non-network pairs will have timber sales within a 2.1-mile radius.

33. What is your administrative unit’s policy regarding pairs of spotted owls found outside SOHAs and in proposed timber sales? (A)

Forest Service:

Responses indicated no formal policy. Cases are dealt with individually through the formal Biological Evaluation process. Most individuals indicated that, in the absence of confirmed nesting, the sale will proceed as planned.

Bureau of Land Management:

Responses indicate that no clear, written policy exists. Situations are dealt with case by case.

34. What is your administrative unit's policy regarding pairs of spotted owls found outside SOHAs in sales under contract? (A)

Forest Service:

Answers indicated no policy. Little or no adjustment is apparently made in a sale under contract, unless a nest tree is located. Only two actual "buy-backs" were cited. Respondents indicated that adjustments (within terms of the contract) were possible in units or sale boundaries, with mutual consent.

Bureau of Land Management:

Responses indicated that no clear policy exists. Most indicated that seasonal restrictions would be implemented to avoid cutting during the nesting season, if nesting was occurring.

35. Is it any different if the pair is nesting? (A)

Forest Service:

Answers reflected confusion about actual policy. Some persons stated that they knew of no policy; others cited a variety of guidelines. The general situation seems to be that the nest tree is saved and an area (differing in size from Forest to Forest) is protected around it for the nesting season. Usually, the area is cut thereafter. The primary concern is to avoid violation of the Migratory Bird Treaty Act.

Bureau of Land Management:

No policy exists. Answers varied and reflected a difference in approach among BLM Districts—either to treat all discoveries of pairs as if a nest existed or to treat nest discoveries differently. Generally, an area around the nest is protected through the nesting season.

Sustained Yield (ASQ)

36. Are management considerations for spotted owls constraining your ability to meet timber harvest targets? Or is it the other way around? Are timber harvest targets constraining your ability to meet spotted owl management direction as it currently exists? (A)

Forest Service:

The following tabulation summarizes responses from the 52 FS personnel interviewed:

Owls constrain timber harvest	19
Timber sales constrain management of owls	0

Both situations are true	25
Neither situation is true	2
Answers too vague or evasive to classify	8

Several comments indicated frustration over the current situation lacking stable guidelines: “The guidelines are too fluid, so I can’t plan.” “We have conflicting management direction now.”

Although the question did not specifically ask whether current harvest plans (allowable sale quantity, or ASQ) were sustainable over the long term, 20 of 52 respondents volunteered that they were not. These responses were about equally distributed among line officers, Timber Staff, and Biologists.

Bureau of Land Management:

The following tabulation summarizes responses from the 17 BLM personnel interviewed:

Owls constrain timber harvest	5
Timber sales constrain management of owls	2
Both situations are true	8
Neither situation is true	0
Answers too vague or evasive to classify	2

Four of the 17 persons interviewed volunteered that their current harvest rate exceeds sustainable yield. Several expressed a concern that they were being forced to sustain their timber harvest on a more limited land base.

Many persons commented on the current fluidity of management guidelines: “direction hard to pin down,” “direction conflicting,” “still uncertain what we’re doing for owls,” “need to know how many owls to protect,” “don’t know what direction BLM has for the owls,” “no clear objectives for owls,” “need interim directives.”

Monitoring and Inventory

37. How many of your SOHAs are currently being monitored through the regional monitoring program (FS) or the monitoring handbook program (BLM)? (C)

Forest Service:

Totaled responses indicated that 184 of 438 SOHAs reported by Forests interviewed were being monitored. in general, all Forests in both Regions a apparently monitoring all or nearly all of the SOHAs called for in the monitoring program design.

Bureau of Land Management:

Sixty-eight of 71 agreement areas reported by Districts interviewed are being monitored.

38. Is your administrative unit monitoring additional SOHAs above this number or gathering additional data? (C)

Of the 22 FS and BLM Biologists responding, 18 indicated that they were monitoring additional SOHAs or gathering additional data.

Additional effort went into surveys of timber sales and monitoring of non-network sites, areas of low occupancy, and random areas.

39. Are monitoring protocols being followed? (C) Forest Service:

Forest Service:

Of the 18 Forest Service responses, all answered yes."

Bureau of Land Management:

Of six BLM Biologists, three said yes," and three "no." The number of visits to a site varies (from three to seven, according to responses). The negative BLM responses were related to inadequate time to complete the maximum number of visits stipulated by protocol.

40. Were you funded in an adequate and timely fashion to accomplish your monitoring, inventory, and sale survey activities? (A)

Seventy-two persons responded to this question (yes-33; no-39). This was nearly evenly split within the FS (yes-29; no-27), but only 25% of the BLM units responded "yes" (yes-4; no-12).

Respondents often answered yes" for monitoring but "no" for inventory or sale surveys. Funding arrived late for many Forests. Many respondents indicated that the rest of the wildlife program suffered because so much effort went into the owl work. Funding was insufficient to cover all costs. The time was often too short to hire and adequately train field personnel.

41. Are staffing levels adequate to complete all facets of spotted owl work required on your unit? (Includes project surveys, monitoring, habitat surveys, SOHA delineation, and verification, etc.) (A)

Sixty-four persons responded to this question (FS: yes-10; no-37) (BLM: yes-4; no-13).

Those who said "yes" were most often line officers or Timber Staff. Some Forest Service and BLM Districts assigned nonbiologists to accomplish spotted owl assignments.

42. **Have you had difficulty hiring field crews for monitoring and project survey work? (A)**

Sixty-two persons responded to this question (FS: yes-20; no-25) (BLM: yes-9; no-8).

Problems mentioned were “not enough experienced people are available”; “had to use staff to do sale surveys”; “need more lead time to hire, plan, train”; and “need more permanent biologists and technicians for consistency.”

Sale Surveys

43. **Have all project areas been surveyed for spotted owls to a minimum standard? (A)**

Sixty-nine persons responded (FS: yes-46; no-6) (BLM: yes-12; no-5).

Most areas were completed. Projects not surveyed are planned to be done next season.

44. **Is so, please explain the standard. (A)**

National Forests:

Most people who responded were aware of the three-visit “mini-protocol” for checking occupancy on sale areas. The few who did not know said that visits were done “to protocol” and probably were referring to the Inventory and Monitoring Protocol. Persons so responding, or who responded with “I don’t know,” were usually Timber Staff.

Bureau of Land Management:

BLM responses varied; most indicated a three-visit minimum. Others responded that one to two visits were minimums.

45. **If not, please explain. (A)**

Reasons given at the few places where not all sites received three visits were “too many sale areas to check”; “not enough time”; and “got a late start.” Not making three visits was mentioned only at the Forest District level, however.

46. Are new data about spotted owl locations being used and evaluated to improve spotted owl networks (that is move SOHAs to sites with better occupancy)? (A)

Thirty-four of 51 respondents answered that new data were being used to improve networks. This belief was pervasive in Forests, but only half the respondents in Districts felt that changes were being made. Adjustments to SOHAs were definitely being made on three of the nine Forests in our sample. One Forest indicated that some changes had been made, but they were a result of conferencing with the Fish and Wildlife Service, not in response to new data.

Contradictions were noted in responses from two Forests. A line officer on one Forest assumed that changes were being made, but this assumption was not supported by staff. In the other, District staff thought some significant changes were in order but would not suggest them because the network was supposedly handled by the Forest. The Forest staff said, however, that some minor changes had been made but that no proposals for change had been received from the District.

In at least two cases, changes were not made because they would require changes in the Land Management Plan (or the interim Plan). In another instance, a line officer thought that with the SEIS completed, they should try to hold things constant and not make changes.

Bureau of Land Management:

Answers were evenly divided among those responding yes" and "no." District personnel tended to believe changes were being made, but the reverse was true at the Area level. One District felt that no changes were being made because the ODFW sites were fixed by agreement. Several respondents noted a need to make some modifications and hoped this could be accomplished in the next round of planning.

47. If not, please explain. (A)

(Responses included in question 46 above)

E

Chronology of Committee Activities

This appendix documents Committee activities, and identifies the individuals and groups we consulted in the course of this study. The list of abbreviations in the front of the report identifies contributors' affiliations.

11-29 September 1989

Committee members and their supervisors were contacted and arrangements made for serving on the Committee. Office space was obtained in the Forum Building in Portland. Committee members are named below:

***The Interagency Spotted Owl Scientific Committee*[1]**

Jack Ward Thomas, Ph.D., Chief Research Wildlife Biologist, USDA Forest Service, La Grande, Oregon

Eric D. Forsman, Ph.D., Research Wildlife Biologist. USDA Forest Service, Olympia, Washington

Joseph B. Lint, District Wildlife Biologist, USDI Bureau of Land Management, Roseburg, Oregon

E. Charles Meslow, Ph.D., Leader, Oregon Cooperative Wildlife Research Unit, USDI Fish and Wildlife Service, Corvallis. Oregon

Barry R. Noon, Ph.D., Research Wildlife Biologist, USDA Forest Service, Arcata, California

Jared Verner, Ph.D., Chief Research Wildlife Biologist, USDA Forest Service, Fresno, California

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[1] Richard R. Olendorff, Ph.D., Leader, Birds of Prey Research Staff, USDI Bureau of Land Management, Boise, Idaho, was an original member of the committee. Circumstances precluded his continued service. He was replaced by Joseph B. Lint.

Appendix E: Chronology

4-6 October

The Committee met in Portland to plan activities necessary to accomplish its mission. This schedule covered the period 11 October to 20 December, the date set in the charter for comments to the FWS for use in their decision process for whether to list the northern spotted owl as a threatened species pursuant to the Threatened and Endangered Species Act. Observer-advisors and technical support staff were selected. Those persons are named below:

State Observers-Advisors to the Committee

Charles R. Bruce, Nongame Wildlife Biologist. Oregon Department of Fish and Wildlife, Corvallis, Oregon

Gordon I. Gould, Jr., Nongame Wildlife Biologist, California Department of Fish and Game, Sacramento, California

David W. Hays, Nongame Wildlife Biologist, Washington Department of Wildlife Olympia, Washington

Interest Groups-Observer-Advisors to the Committee

Larry L. Irwin, Ph.D., Wildlife Program Leader, National Council for Air and Stream improvement, Corvallis, Oregon

Dennis D. Murphy, Ph.D., Associate Director, Center for Conservation Biology, Stanford University, Palo Alto, California

David S. Wilcove, Ph.D., Chief Ecologist, The Wilderness Society, Washington, DC.

Technical Staff-Advisors

Mary Anne Bishop, Ph.D., Research Wildlife Biologist, USDA Forest Service, La Grande, Oregon

A. Grant Gunderson, Wildlife Biologist, Pacific Northwest Regional Office, USDA Forest Service, Portland, Oregon

Douglas B. Houston, Ph.D., Research Biologist, Pacific Northwest Region, National Park Service, Port Angeles, Washington

Bruce G. Marcot, Ph.D., Area Wildlife Ecologist, USDA Forest Service, Portland, Oregon

Barry S. Mulder, Coordinator for the Spotted Owl Program, U.S. Fish and Wildlife Service, Portland, Oregon

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Administrative Officer

Nancy F. DeLong, Contracting Specialist, USDA Forest Service, Pendleton, Oregon

Editor

Martha H. Brookes, Technical Publications Editor, USDA Forest Service, Corvallis, Oregon

Note: Additional contributors are listed at the end of the chronological section.

16-18 October

This period was taken up by background briefings for the Committee as follows:

Barry Mulder, FWS, Portland, OR. The Endangered Species Act and FWS activities in consideration of listing of the northern spotted owl.

Terri Simon-Jackson, FS, Region 5, San Francisco, CA. Overview of spotted owl management issues in National Forests in California, USDA Forest Service.

Kathy O'Halloran, FS, Region 6, Portland, OR. Spotted owl monitoring and inventory, Pacific Northwest Region, USDA Forest Service.

Tern Simon-Jackson, FS, Region 5, San Francisco, CA. Spotted owl monitoring and inventory, Pacific Southwest Region, USDA Forest Service.

Joe Lint, BLM, Roseburg, OR. Monitoring and inventory of spotted owls on BLM lands.

Joe Lint, BLM, Roseburg, OR. Overview of northern spotted owl habitat management on BLM lands.

Grant Gunderson, FS, Region 6, Portland, OR. Overview of northern spotted owl habitat management on National Forests in the Pacific Northwest Region.

Charles Bruce, ODFW, Corvallis, OR. Activities and recommendations to date of the spotted owl subcommittee of Oregon/Washington Interagency Wildlife Committee.

Russ Peterson and Randy Tweeten, FWS, Portland, OR. Fish and Wildlife Service criteria for evaluating timber sales as related to the overall welfare of the northern spotted owl.

Russ Peterson and Randy Tweeten, FWS, Portland, OR. A Fish and Wildlife Service field office perspective of the spotted owl situation.

David Hays, WDW, Olympia, WA. Overview of the current status of spotted owls in Washington.

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Charles Bruce, ODFW, Corvallis, OR. Overview of the current status of spotted owls in Oregon.

Gordon Gould, CDFG, Sacramento, CA. Overview of the current status of spotted owls in California.

Rick Brown, National Wildlife Federation, Portland, OR> The environmental community's view on the spotted owl management situation.

Larry Irwin, NCASI, Corvallis, OR. The NCASI view of the spotted owl management situation.
Hal Salwasser, FS, Fish and Wildlife, Washington, DC. Development of the Final Supplemental Environmental Impact Statement and the Forest Service Chief's Record of Decision on spotted owl management.

David Hays, WDW, Olympia, WA. Spotted owl monitoring and inventory in Washington.

Charles Bruce, ODFW, Corvallis, OR. Spotted owl monitoring and inventory in Oregon.

Gordon Gould, CDFG, Sacramento, CA. Spotted owl monitoring and inventory in California.

Douglas Houston, NPS, Port Angeles, WA. Spotted owl inventory and the National Park Service perspective on management of spotted owl habitat.

Roger Nesbitt, Office of Solicitor, Portland, OR; Val Black, OGC, Portland, OR; and Ron Swann, Office of Solicitor, Portland, OR. Current legislation and litigation concerning the spotted owl.

19-20 October

This period was taken up with inspection of the spotted owl habitat and research study of areas in the Olympic peninsula, including the Quinault, Soleduck, and Quilcene Ranger Districts, Shelton Cooperative Sustained Yield Unit, and the Department of Natural Resources' Clearwater Block. The I-90 "corridor" within the Mount Baker-Snoqualmie National Forest in the Cascades was visited, as well as the Lake Wenatchee and Leavenworth Ranger Districts of the Wenatchee National Forest on the eastside of the Cascades. Participants included:

Heather Murphy, FS, Wenatchee, WA
Jeff Lewis, FS, PNW, Olympia, WA
David Rolph, FS, Olympia, WA

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23-25 October

This period was devoted to presentations concerning on-going research on the northern spotted owl. Speakers and topics were as follows:

Eric Forsman, FS, PNW, Olympia, WA. Spotted owl research on the Olympic Peninsula—Home-range size, habitat utilization, prey studies.

Gary Miller, OSU, Corvallis, OR. Home-range and habitat use by the spotted owl in the central Oregon Cascades.

Robert Anthony, FWS, Corvallis, OR. Spotted owl prey studies in the Oregon Cascades.

E. Charles Meslow, FWS, Corvallis, OR. Home-range and habitat use of spotted and great horned owls as related to forest fragmentation in Oregon and Washington.

Andrew Carey, FS, PNW, Olympia, WA. Quality of spotted owl habitat in the southern Cascades.

Andrew Carey, FS, PNW, Olympia, WA. Interaction and movement of spotted owls.

Andrew Carey, FS, PNW, Olympia, WA. Home-range and habitat use in the southern Coast Range.

Jared Verner, FS, PSW, Fresno, CA. Spotted owl research in the Sierra Nevada: Home-range size and composition.

Barry Noon, FS, PSW, Arcata, CA. Review of ongoing research in the Klamath Province.

Steve Self, TAC, Sacramento, CA; Steve Kerns, Pacific Lumber Co., Scotia, CA; Malcom Pious and Chris Rowney, Louisiana-Pacific Corn., Calpella, CA. Occurrence of spotted owls in managed timber stands on private lands in California.

Mark Boyce, Univ. Wyoming, Laramie. Research of the U.S. Forest Service spotted owl viability modeling and an overview of NCASI-sponsored research on metapopulation modeling.

Larry Irwin and Joe Buchanan, NCASI, Corvallis, OR. Review of nest tree (habitat) studies on the Wenatchee National Forest.

Larry Irwin and Joe Buchanan, NCASI, Corvallis, OR. Review of studies of spotted owls in managed forests of southwest Washington.

Alan Franklin, HSU, Arcata, CA. Review of ongoing spotted owl research in Northern California—The Willow Creek Study Area.

R.J. Gutiérrez and Pat Ward, HSU, Arcata, CA. Review of ongoing spotted owl research In northern California, southern California, central California, and Utah.

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Chris Servheen, FWS, Missoula, MT. Grizzly bear recovery planning.

26-29 October

This period was taken up with on-the-ground inspection of spotted owl habitat in coastal and interior northern California at the invitation of the Timber Association of California. Coastal redwood forests on private timber-company lands south and east of Arcata were visited, as well as mixed-conifer interior forest lands north of Bedding near Dunsmuir and Hilt. For comparison, tours were conducted through an FS study area for the California spotted owl subspecies in the Sierra National Forest east of Fresno. Participants included:

Steve Avery, FS, PSW, Fresno, CA
Lowell Diller, Frostburg State University/Simpson Timber Co., Korbel, CA
Bill Houston, Simpson Timber Co., Korbel, CA
Steve Kerns, Pacific Lumber Co., Scotia, CA
Ed Murphy, Sierra Pacific Industries, Redding, CA
Don Neal, FS, PSW, Fresno, CA
Tom Nelson, Sierra Pacific Industries, Redding, CA
Malcom Pious, Louisiana-Pacific Co., Calpella, CA
Steve Self, Timber Association of California, Sacramento, CA
George Steger, FS, PSW, Fresno, CA
Grace Terrazas, FS, Sierra NF, Fresno, CA
Scott Warner, Sierra Pacific Industries, Bedding, CA
Jeff Webster, Fruit Growers Supply Co., Hilt, CA

30 October-3 November and 6-10 November

In Oregon, Washington, and California, 17 National Forests and 6 BLM Districts (roughly equivalent to a National Forest) provide habitat for the northern spotted owl. Nine National Forests and one Ranger District within each of these Forests were randomly selected for study on the status of spotted owl management and survey efforts. Three BLM Districts and one Area (roughly equivalent to a Ranger District in a National Forest) in each District were likewise selected. Interviews were conducted with the Forest Supervisors and District Managers, the Timber Management Officers, the Wildlife Biologists, and the District Rangers or Area Managers on various aspects of spotted owl management activities. These interviews were aimed at disclosing the quality and consistency of management efforts. Each Forest or BLM District was visited for 2 to 3 days by a Committee member and advisor.

Appendix E: Chronology

21 November

The following people continued with the briefing the Committee:

> Harriet Allen, WDW, Olympia, WA. Spotted owl research and status in Washington.
>
> Tom Hamer, FS, PNW, Olympia, WA. The cooperative study on barred owls and spotted owls in the Washington Cascades.
>
> Michael Lennartz, FS, Clemson, SC. Development of the red-cockaded woodpecker conservation plan.

28 November

Portland workshop on alternative silvicultural systems. Presenters included:

> Mike Amaranthus, FS, Siskiyou NF, OR. Salvaging the ecosystem after the 1987 fires.
>
> Dean DeBell, FS, PNW, Olympia, WA. Alternative silviculture on Washington Department of Natural Resource lands.
>
> Jerry Franklin, FS, PNW; UW, Seattle, WA. Perspectives and directions.
>
> Bob Lewis, BLM, Medford District. Modeling old-growth management regimes.
>
> Peter Morrison, Wilderness Society, Seattle, WA. Results of old-growth forest inventory.
>
> Chadwick Oliver, UW, Seattle, WA. Perspectives and directions.
>
> David Perry, OSU, Corvallis, OR. Climate change and forest stability considerations.
>
> Karel Stoscek, UI, Moscow, ID. Alternative silviculture in the interior west.
>
> John Tappeiner II, OSU, Corvallis, OR. Experiments on the OSU School Forest.
>
> Jared Verner, FS, PSW, Fresno, CA. Spotted owl habitat perspectives.

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29 November

Group discussion workshop on technically feasible silvicultural alternatives that may produce spotted owl habitat. Participants included:

Phil Aune, FS, PNW, Redding, CA
Dean DeBell, FS, PNW, Olympia, WA
Jerry Franklin, UW/FS, PNW, Seattle, WA
Alex Goedhard, Weyerhaeuser Company, Centralia, WA
Miles Hemstrom, FS, Willamette NP, OR
Ross Johnson, CDF, Sacramento, CA
Logan Jones, ODF, Salem, OR
Wendall Jones, FS, Region 6, Portland, OR
Walt Knapp, FS, Region 6, Portland, OR
Bob Lewis, BLM, Medford District, OR
Bob Metzger, BLM, Portland, OR
Tom Nelson, Sierra Pacific Industries, Redding, CA
Tom Spies, FS, PNW, Corvallis, OR
John Tappeiner II, OSU, Corvallis, OR

30 November

Presentations continued with the following speakers:

Dan Doak, UW, Seattle, WA. Population modeling.

Peter Morrison, Wilderness Society, Seattle, WA. Old-growth mapping on National Forests.

Charles Sisco, National Audubon Society, Olympia, WA. Old-growth mapping on National Forests.

1-3 December

This period was taken up with on-the-ground inspection of spotted owl habitat research areas near the H.J. Andrews Experimental Forest and the BLM Eugene District McKenzie Resource Area plus private lands in the central Oregon Cascades, the Coast Range Province study areas of the Eugene and Roseburg BLM District and the Klamath Province study area on the Medford District BLM. Participants included:

Richard Bonn, BLM, Medford, OR
Ray Bosch, BLM, Eugene, OR
Robin Bown, BLM, Roseburg, OR
Larry Irwin, NCASI, Corvallis, OR
Lee Lauritzen, BLM, Eugene, OR
Gary Miller, OSU, OCWRU, Corvallis, OR
Greg Miller, BLM, Eugene, OR
Frank Oliver, BLM, Roseburg, OR
Janice Reid, FS, PNW, Roseburg, OR

Gail Schaefer, BLM, Roseburg, OR
Steve Speich, NCASI, Corvallis, OR
James Sweeney, Amer. For. Res. Alliance, Washington, DC
Charles Thomas, BLM, Eugene, OR
Jim Thrailkill, OSU, OCWRU, Corvallis, OR
Frank Wagner, OSU, OCWRU, Corvallis, OR

4-20 December

Comments were compiled and submitted to the FWS on their proposed rule to list the northern spotted owl as ‘threatened” under the Endangered Species Act.

21 December-18 January 1990

Committee continued data analysis and writing of conservation plan.

19 January

Briefing of the Committee by members of the Northwest Forest Resources Council including:

John Hampton, Willamina, OR
Dennis Hayward, Eugene, OR
Ross Mickey, Eugene, OR
Mark Rutzick, Portland, OR
Ralph Saperstein, Portland, OR

22-23 January

Agency biologists from the Forest Service and BLM from California, Oregon, and Washington were invited to a Portland workshop on spotted owl conservation. The group provided appraisals of management options and opportunities within their respective States and work areas. Attendees included:

Bea Anderson, FS, Mendocino NP, CA
Norm Barrett, FS, Willamette NF, OR
Jim Bottorff, FWS, Portland, OR
Don DeLorenzo, FS, Region 5, San Francisco, CA
Phil Detrich, FWS, Sacramento, CA
Tony Hacking, FS, Klamath NF, CA
Jim Harper, BLM, Medford, OR
Barbara Hill, FS, Gifford Pinchot NF, WA
Wayne Logan, BLM, Salem, OR
Jeff Mattison, FS, Six Rivers NF, CA
Jim Michaels, FWS, Olympia, WA
Bill Neitro, BLM, Oregon State Office, Portland, OR
Rick Newton, FS, Mount Hood NF, OR
Kathy O’Halloran, FS, Region 6, Portland, OR
Frank Oliver, BLM, Roseburg, OR
A. Sonny Paz, FS, Mount Baker-Snoqualmie NF, WA

Karen Raftery, FS, Klamath NF, CA
Jo Richards, FS, Wenatchee NP, WA
Lynn Roberts, FS, Six Rivers NF, CA
Tern Simon-Jackson, FS, Region 5, San Francisco, CA
Steve Spangle, FWS, Sacramento, CA
Dede Steele, FS, Willamette NP, OR
Marilyn Stoll, FS, Olympia, WA
Charles Thomas, BLM, Eugene, OR
Lee Webb, FS, Siskiyou NP, OR

24-25 January

Many Committee members and advisors attended the Forest Service/Spotted Owl Research and Development meeting in Portland. Results of research and mor of all three subspecies were reviewed. Attendees included:

Jim Baldwin, FS, PSW, Berkeley, CA
Tom Beebe, FS, Wenatchee NF, WA
Charles Bruce, ODFW, Corvallis, OR
Andy Carey, FS, PNW, Olympia, WA
Robert Crabtree, UI, Moscow, ID
Don DeLorenzo, FS, Region 5, San Francisco, CA
Ken Dixon, WDW, Olympia, WA
Leon Fisher, FS, Region 3, Albuquerque, NM
Keith Fletcher, FS, Region 3, Albuquerque, NM
Eric Forsman, FS, PNW, Olympia, WA
Chris Foster, FS, PNW, Olympia, WA
Alan Franklin, HSU, Arcata, CA
Gordon Gould, CDFG, Sacramento, CA
Grant Gunderson, FS, Region 6, Portland, OR
Tom Hamer, FS, PNW, Olympia, WA
Eric Hansen, Yakima Indian Nation, WLF, Toppenish, WA
David Hays, WDW, Olympia, WA
Scott Horton, FS, PNW, Olympia, WA
Larry Irwin, NCASI, Corvallis, OR
Fred LeBan, UI, Moscow, ID
Jeff Lewis, FS, PNW, Olympia, WA
Joe Lint, BLM, Roseburg, OR
Sandra Martin, FS, PNW, Wenatchee, WA
Garland Mason, FS, PSW, Berkeley, CA
Tim Max, FS, PNW, Portland, OR
Charles Meslow, FWS, OCWRU, Corvallis, OR
Joe Meyer, UW, McKinleyville, CA
Gary Miller, OSU, OCWRU, Corvallis, OR
Barry Mulder, FWS, Portland, OR
Bill Neitro, BLM, Portland, OR
Barry Noon, FS, PSW, Arcata, CA
Kathy O'Halloran, FS, Region 6, Portland, OR
Kevin Peeler, FS, PNW, Olympia, WA

Martin Raphael, FS, PNW, Olympia, WA
Keith Severson, FS, RMS, Tempe, AZ
Tern Simon-Jackson, FS, Region 5, San Francisco, CA
Steve Spangle, FWS, Sacramento, CA
Nancy Tilghman, FS, FER, Washington, DC
Jared Verner, FS, PSW, Fresno, CA
Ed F. Wicker, FS, RMS, Port Collins, CO
Cindy Zabel, FS, PSW, Arcata, CA

30 January

Jack Thomas and Kent Mays met with an interagency group in Sacramento to discuss ongoing Committee activities and to solicit advice on spotted owl management in northern California. Attendees included:

Dean Cromwell, CBF
Robert Ewing, CDF
Gordon Gould, CDFG
Harley Greiman, FS, Region 5
Dave Harlow, FWS Region 1
David Jay, FS, Region S
Jon Kennedy, FS, Region 5
Robert Motroni, CDF
Kent Smith, CDFG
Steve Spangle, FWS Region 1
Christine Sproul, Counsel, CRA

3-4 February

Meeting with leading conservation biologists to discuss alternative conservation strategies. Attendees included:

Mark Boyce, University of Wyoming, Laramie, WY
R.J. Gutiérrez, Humboldt State University, Arcata, CA
Hal Salwasser, FS, Washington, DC
Daniel Simberloff, Florida State University, Gainesville, FL
Michael Soulé, University of California, Santa Cruz, CA
Tom Spies, FS, PNW Research Station, Corvallis, OR
Dean Urban, University of Virginia, Charlottesville, VA
John Wiens, Colorado State University, Port Collins, CO

Appendix E: Chronology

8, 15-16 February

Work with silvicultural alternatives group in Portland led to preparation of Appendix S—Silvicultural Experiments for Habitat Management.

Dean DeBell, FS, PNW, Olympia, WA
David Hays, WDW, Olympia, WA
Waft Knapp, FS, Region 6, Portland, OR
Chadwick Oliver, UW, Seattle, WA
John Tappeiner II, OSU, Corvallis, OR

16 February

Thomas met with the Interagency Spotted Owl Committee representatives from R5 and R6 FS, State wildlife directors from California, Oregon, and Washington, BLM, and National Park Service. The group was briefed on the progress of the Scientific Committee. Attendees included:

Ed Allen, FS, Portland, OR
D. Dean Bibles, BLM, Portland, OR
Hugh Black, FS, Portland, OR
John Butruille, FS, Region 6, Portland, OR
Mike Grouse, BLM, Portland, OR
John Pay, FWS, Washington, DC
Randy Fisher, ODFW, Portland, OR
Dave Harlow, FWS, Sacramento, CA
Richard Johnson, BLM, Sacramento, CA
Catherine Kennard, CRA, Sacramento, CA
Mletek Kolipinski, NPS, Sacramento, CA
Bill Martin, FWS, Portland, OR
Kent Mays, FS, PNW, Portland, OR
Charles Odegaard, NPS, Seattle, WA
Charlie Philpot, FS, PNW, Portland, OR
Marvin Plenert, FWS, Portland, OR
Ed Shepard, BLM, Washington, DC
Curt Snitch, WDW, Olympia, WA
Kent Smith, CDFG, Sacramento, CA
Robert P. Smith, FWS, Portland, OR
Elaine Zielinski, BLM, Portland, OR

21 February

Research meeting with forest-industry group concerning planned research on private land in northern California. Attendees included:

Larry Irwin, NCASI, Corvallis, OR
Ross Mickey, Northwest Timber Association, Eugene, OR
Tom Nelson, Sierra Pacific Industries, Redding, GA
Tharon O'Dell, Simpson limber Co., Korbel, CA
Malcom Pious, Louisiana Pacific, Calpella, GA

Appendix E: Chronology

12-16 March

Draft of conservation plan was completed and submitted for peer review to scientists selected by scientific or professional societies:

American Ornithologists' Union
Russell Lande, Ph.D.
Department of Ecology & Evolution
University of Chicago
Chicago, IL

Ecological Society of America
John Weins, Ph.D.
Department of Biology
Colorado State University
Port Collins, CO

Society for Conservation Biology
Michael Gilpin, Ph.D.
Department of Biology
University of California, San Diego
La Jolla, CA

Society of American Foresters
W.H. Lawrence, Ph.D.
905 Spring Lane
Centralia, WA

The Wildlife Society
Larry Harris, Ph.D.
Department of Wildlife & Range Sciences,
University of Florida
Gainesville, PL

15 March

The agency directors were briefed in Portland, OR, on the content of the draft plan.

16 March

Wildlife biologists from BLM Districts in Oregon were invited to provide information on options under consideration for the final conservation plan.

Ray Bosch, BLM, Eugene, OR
Robin Bown, BLM Roseburg, OR
Ralph Culbertson, BLM, Coos Bay, OR
Jim Harper, BLM, Medford, OR
Bill Hudson, BLM, Coos Bay, OR
Carole Jorgensen, BLM, Eugene, OR
Wayne Logan, BLM, Salem, OR

Larry Mangan, BLM Coos Bay, OR
Greg Miller, BLM, Eugene, OR
Jerry Mires, BLM, Roseburg, OR
Frank Oliver, BLM, Roseburg, OR
Gayle Sitter, BLM, Klamath Falls, OR
Charles Thomas, BLM, Eugene, OR
Joe Witt, BLM, Roseburg, OR

1st Week in April 1990

Final report completed.

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Don DeLorenzo	FS, R-5, San Francisco, CA
Phil Dietrich	FWS, Sacramento, CA
Chris Foster	FS, PNW, Olympia, WA
Mike Gertsh	FS, Shasta-Trinity NF, Redding, CA
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F

Characterization of Spotted Owl Habitats in Washington, Oregon, and Northern California

Introduction

In this appendix, we characterize spotted owl habitat as reported in many different studies of habitat that spotted owls use for foraging, roosting, and nesting. Although we cannot "define" their habitat, we can describe the attributes of forest stands that spotted owls use. To set some ground rules, we first explain terminology used to describe various qualitative states of owl habitat and explore the question of habitat "need."

Habitat Quality

Discussions of an organism's habitat usually include assessments of its relative "value" or "suitability." For any species, habitat suitability for various life functions— breeding, feeding, and cover—is not identical in all possible habitats. Suitability of different types of habitat can be graded from excellent to poor, which means that habitat suitability values tend to be continuous as opposed to discrete. Partitioning of habitats into categories, however, facilitates discussion. For the purposes of this report, we follow the traditional approach of evaluating habitat quality based on use versus availability of different types of habitat. Habitats selected in excess of availability by the majority of owls were considered to be suitable for classification as superior habitat. Superior habitat may be optimum, meaning that it is the best possible for the organism. We can never know whether better habitat exists elsewhere for a species, however, so we reject "optimum habitat" as potentially misleading.

Habitats that were seldom used in excess of availability, were used in proportion to availability by many individuals, and were used less than expected by many others are considered marginal. Marginal habitat at the upper end of the scale may be adequate for all life-history needs of a species, but marginal habitat at the lower end may be unsuitable for most or all of its life-history needs. This does not mean that marginal habitats are unimportant to a given species. They may be vital for maintaining a reservoir of individuals (floaters, see appendix O) that can replace others lost from suitable or superior habitats. They may also contain scarce habitat elements critical to the species, but used infrequently enough that measures of "use" provide poor indices of their importance. Furthermore, in areas with an amount of superior and suitable habitat slightly less than an organism typically requires, availability of additional marginal habitats may tip the balance in favor of successful occupancy or even occasional breeding. This property of "marginal" habitats means that caution must be used when interpreting their significance to a species.

Appendix F: Habitat

Habitats that were selected less than expected by the majority of owls were considered to be poor in quality, or unsuitable habitat. Over the long term, unsuitable habitat typically fails to provide the needs of a species, either for breeding, feeding, or cover. Unsuitable habitat is normally unoccupied; breeding occurs infrequently there and is typically unsuccessful. Even survival by single individuals is tenuous. We realize that organisms sometimes turn up in strange places, especially if they are capable of long-distance movements—usually flying species such as insects, birds, and bats. But the significance of these events lies in the mobility of the species, not in the capacity of the habitat to support them.

For analyses of habitat suitability, an important consideration is the relative proportion of available locations or amounts of time spent in the different habitats. Those habitats that consistently account for the greatest proportion of use should be considered at least adequate, even if they are not used in excess of availability.

Habitat Need

The issue of habitat "need" commonly arises in developing a strategy for conservation of a species. Discussion here is largely appropriated from the excellent summary of this issue by Ruggiero et al. (1988). Wildlife biologists who provide information to aid management decisions are often challenged to distinguish between what a species **uses and prefers**, and what it **must have**. We contend, however, that the full range of a species' needs cannot be determined—that it is generally unknowable and unresearchable. Instead, we have adopted the following operational approach in dealing with the ecological dependency of spotted owls:

> **When patterns of a species' abundance and distribution show a consistent, close association with a particular type or types of habitat, we assume that the habitat is essential for the species' persistence. We contend that habitat selection is a behavior that reflects the long-term needs of a given species, and that it has so evolved over thousands of years of varying environmental conditions as a result of natural selection. Consequently, preference for a given habitat or habitat attribute likely indicates a need.**

We believe this is the only tenable position, for several reasons. First, unequivocal determination of whether habitat use or preference reflects the true "needs" of a species could be settled only by experimentation, which we consider unfeasible. An experiment to test a state of habitat dependency must consider responses of populations rather than individuals. The occasional occurrence of breeding by even one or a few individuals in a given habitat must be weighed against the preponderance of occurrence and breeding in another. To manage a species on the assumption that exceptional behavior is the norm would be imprudent.

An experiment on habitat dependency must deal with long-term persistence as well as short-term existence. Habitat that can sustain a population in the short term may be inadequate in the face of, say, a 50-year drought (the eventual occurrence of which is virtually certain).

Appendix F: Habitat

Because of lag effects, especially for species such as the spotted owl that have a long life span, certain processes leading to extinction may not be expressed in experimental results for decades. Meanwhile, habitat conditions could deteriorate to the point that some critical threshold is passed and the extinction of the species is assured.

Experimental verification of the ecological dependency of spotted owls would entail the potential sacrifice of a large portion of the population. Replication of the experiment could jeopardize the population. This option is unacceptable for a species whose very persistence is in question. Unplanned, large-scale experiments are in progress in forested landscapes, as logging reduces the amount of remaining habitat. By taking advantage of these uncontrolled experiments, we may learn something about the effects of habitat loss on spotted owls.

Although we do not believe that experimentation can tell us the precise kinds, amounts, and configurations of habitat that would meet minimum population needs, we do believe that research and experimentation can provide us with much better information than is currently available on habitat needs of spotted owls. That information will allow us to determine a range of habitats within which we can continue to meet the species' needs.

Methods

In Washington and Oregon, northern spotted owls occur in a variety of forest zones including western hemlock, white fir, Pacific silver fir, Sitka spruce, mixed-evergreen, mixed-conifer, and coastal redwoods. In northern California, the birds find suitable habitats in a variety of forest zones: Douglas-fir, often with a hardwood component; redwood/Douglas-fir; redwood, often with a hardwood component; Douglas-fir/white fir; mixed-evergreen (tanoak, Pacific madrone, Douglas-fir): and mixed-conifer.

Within these zones, habitat used by the owls can be described at three scales: stand structure, stand condition, and landscape. Stand structure is based on quantitative measurements of vegetative plots centered at or around a roost, foraging, or nest location. Information on stand structure usually includes canopy closure, size and abundance (basal area and density) by tree species, and ground cover. Stand condition is a broad seral-stage classification based on such factors as tree age and d.b.h., and canopy closure. At the landscape scale, habitat use is described in several ways, including the proportions of habitat types within a home range compared to the general landscape, and through indices of habitat fragmentation.

Although numerous spotted owl surveys demonstrate associations with stand or landscape conditions (for example, Forsman et al. 1987, Hays et al. 1989a, Irwin et al. 1989b, Pious 1989), they do not provide information on habitat use and selection by stand structure. Nighttime response locations are often estimated from owls calling a considerable distance from the observer (Hays et al. 1989a). Spotted owls will also travel as far as 3/4 of a mile to respond to taped calls. in addition, although recorded and oral calls may elicit a response from territorial owls defending a nest site, non-breeders or birds outside their defended territories may not respond (Mills et al.1989).

Appendix F: Habitat

For the above reasons, the following information on habitat use is primarily based on studies that examined stand structure and stand conditions in areas known to be used by owls. Use and selection ‘Of foraging and roosting habitat were determined from locations of radio-marked owls. Use of nesting habitat was determined from nest sites of radio-marked, banded, and unbanded owls.

In all of the radio-telemetry studies that we examined, the spotted owl’s habitat use was described in terms of stand conditions, which were usually determined by a combination of photo interpretation; inventory records of BLM, FS, or both; Landsat imagery; and ground reconnaissance. Stands were typically classified as old growth, mature or large sawtimber, young or pole/medium, and pole/sapling or shrub/forb/sapling.

With the exception of old growth, definitions for stand conditions varied widely among studies (table Fl). Old growth was usually defined as a dominant overstory >200 years old, with a multilayered, multispecies canopy, relatively high canopy closure, and large numbers of snags and logs. Definitions of old-growth d.b.h. sizes for dominant trees ranged from >30 to ‘39 inches, and for two studies in Washington (Allen et at. 1989, Hays et at. 1989b) required codominant trees >16 inches in d.b.h. Definitions of stands designated as mature or large sawtimber typically included an even aged stand with a minimum age of dominant trees ranging from >70 to >100 years, and minimum d.b.h. ranging from 16 to 21 inches.

Table Fl—Definitions of stand conditions in various studies used to compile tables F2, F3, F4, F5, and F9

Study	Condition	Definition
Sisco and Gutiérrez 1984; Solis 1983	Old-growth/ mature	Mixture of old-growth trees >200 years old, >35 inches in d.b.h.; mature trees >70 years old, >21 inches in d.b.h.
	Pole/medium	Trees 15 to 70 years old, 5 to 20 in d.b.h.
	Bush/seedling/ sapling	Trees 0 to 15 years old, <5 inches in d.b.h.
	Grass/forb	
Forsman et al. 1984	Old-growth	Trees >200 years old, >39 inches in d.b.h.; multilayered stands; unlogged
	Mature	Trees 81 to 200 years old, 15.7 to 51 inches in d.b.h.; unlogged
	“Young” in the Cascades	Trees 61 to 80 years old, 10 to 29.5 inches in d.b.h.; unlogged
		Trees 31 to 60 years old, 8 to 24 inches in d.b.h.
	“Young” in the central Coast Range	Trees 61 to 80 years old, 10 to 29.5 inches in d.b.h.; unlogged
		Trees 36 to 60 years old, 8 to 24 inches in d.b.h.
	“Sapling” in the Cascades	Trees 21 to 30 years old, 4 to 7.9 inches in d.b.h.
		Trees 5 to 20 years old

Table Fl—continued

Study	Condition	Definition
	"Sapling" in the central Coast Range	Trees 25 to 35 years old, 4 to 7.9 inches in d.b.h. Trees 5 to 24 years old
	Clearcut	Overgrown with shrubs, or grass/forb
Allen et al. 1989	Old Growth	Trees >30 inches in d.b.h.; codominants >16 inches in d.b.h.; multilayered
	Large sawtimber	Trees in canopy 20 to 31 inches in d.b.h.; few canopy layers
	Small sawtimber	Trees 14 to 20 inches in d.b.h.
	Pole	Trees 6 to 14 inches in d.b.h.
	Open-canopy conifer	Canopy cover 40 to 60%; variety of tree sizes
	Other	Shrub/forb/sapling; shrub/forb/grass; rock/barren; water; snow/shadow
Hays et al. 1989b	Old growth	Trees >32 inches in d.b.h.; codominants >16 inches in d.b.h.; multilayered
	Large sawtimber	Trees 20 to 34 inches in d.b.h.; few canopy layers
	Small sawtimber	Trees 13 to 20 inches in d.b.h.
	Pole	Trees 6 to 13 inches in d.b.h.
	Open Canopy	Canopy cover 40 to 60%; variety of tree sizes
	Other	Shrub/sapling; grass/forb; rock; water; snowfield
Miller and Meslow 1989	Old growth	Doublas-firs >32 inches in d.b.h., >200 years old; multilayered
	Mature	Trees >21 inches in d.b.h., but not old growth
	<Mature	All other stands including clearcuts
Thrailkill and Meslow 1989; Thrailkill and Meslow 1990	Old growth	Trees >34 inches in d.b.h., >200 years old, more than two canopy layers
	Mature	Trees >21 inches in d.b.h., 80 to 199 years old
	Young	Trees 1 to 21 inches in d.b.h., 10 to 79 years old, canopy cover <60%
	Mixed	Primarily young growth with poorly stocked mature/old growth in the overstory; canopy closure variable
	Clearcut	Trees 0 to 9 years old; shrub canopy <40% or devoid of vegetation; trees <1 inches in d.b.h.
	Hardwood/ riparian	Dominated by hardwoods long stream or river; 50 to 100% canopy cover

Table Fl—continued

Study	Condition	Definition
Carey et al. 1990	Old growth	Trees >200 years old, >39 inches in d.b.h., multilayered canopy
	Mature	Trees 100 to 200 years old, 20 to 39 inches in d.b.h., even-aged
	Young	Trees 50 to 100 years old, 8 to 19 inches in d.b.h.
	Pole/sapling	Trees <50 years old, 1 to 8 inches in d.b.h.
	Mixed ages	Generally old growth with inclusions of young or mature stands of <10 acres
	Nonforest	Grass, forb, shrub, and clearcut
	Hardwood/ riparian	All ages (no further definition)
Carey, pers. comm.	Old growth	Trees >39 inches in d.b.h.; multilayered canopy
	Mature	Trees 20 to 39 inches in d.b.h.; even-aged stands
	Young	Trees 8 to 19.9 inches in d.b.h.
	Pole	Trees 4 to 7.9 inches in d.b.h.
	Sapling	Trees 1 to 3.9 inches in d.b.h.
	Mixed old	Old growth with inclusions of young or mature stands of <10 acres
	Mixed Young	Young stands with inclusions of other seral stages
	Hardwood forest	
	Clearcut	
	Nonforest	Grass; forb; shrub
Bown, pers. comm.	Old growth	Trees 35 inches in d.b.h.; multilayered
	Mature	Trees 20 to 40 inches in d.b.h.; relatively uniform size
	Young	Trees 11 to 20 inches in d.b.h., some up to 30 inches; closed canopy

Young stands were lumped into one broad category in some studies (Thrailkill and Meslow 1989, Miller and Meslow 1989) or split into several categories (pole/ sapling, pole/medium, small sawtimber, and so on) in others (Carey et al. 1990, Forsman et al. 1984, Kerns 1989). In general, all of the above definitions for young stands included dominant trees <19 inches in d.b.h. An exception was that of Kerns (1989), who worked in young stands of redwoods that commonly were up to 40 inches in d.b.h.

Appendix F: Habitat

Results of Habitat Studies in Washington and Oregon

Characterization of Habitat used for Foraging and Roosting

Ten studies of habitat use by spotted owls have been completed in Oregon and Washington since 1975 (Allen et al. 1989; Carey, pers. comm.; Carey et al. 1990; Egtvedt and Manuwal 1988; Forsman 1980, 1981; Forsman et al. 1984; Hamer et al. 1989; Hays et al. 1989b; Miller and Meslow 1989; Thrailkill and Meslow 1989,1990). Some of these studies provided separate analyses of foraging and roosting habitat selection. Others combined foraging and roosting locations and analyzed them as one data set. All studies provided information on habitat use related to stand condition.

Results were similar in all studies (tables F2 to F4 for habitat selection). Old growth was the only stand condition that owls consistently used more than expected for foraging and roosting. Among 115 owls radio-tracked in these studies, 97 (84%) used old-growth forests significantly more than expected, and 18 (16%) used them in proportion to availability. The majority (65%) used mature forests in proportion to availability, 21% used them significantly less than expected, and 14% used them significantly more than expected. Young forests were used significantly more than expected by only 4 of 115 owls (3%), but they were used less than expected by >50% of the owls. Clearcuts and very young forest plantations were used very little by any owl studied.

These results suggest that, in general, old-growth forests are superior habitat for spotted owl foraging and roosting in Oregon and Washington. Mature stands are less suitable habitat than old growth, young stands provide marginal habitat, and clearcuts and young plantations (saplings, poles, or both) are unsuitable habitat.

In the only study that provided detailed data on stand structure, Allen et al. (1989) reported on stands intensively used by radio-marked owls in three different areas of Washington (Olympic Peninsula, Gifford-Pinchot National Forest, and Mount Baker-Snoqualmie National Forest). Average densities of live trees in that study were:

Olympic National Forest	(190/acre, $n = 4$)
Gifford Pinchot National Forest	(205/acre, $n = 14$)
Mount Baker-Snoqualmie National Forest	(210/acre, n — 10)

Trees >32 inches in d.b.h. accounted for 11% (Gifford Pinchot National Forest) to 19.7% (Olympic National Forest) of the live trees. Snag densities on the three areas averaged from 25 to 41 per acre. Densities of large snags (>39 inches in d.b.h.) ranged from two per acre (Gifford Pinchot and Mount Baker-Snoqualmie National Forests) to four per acre (Olympic National Forest).

Appendix F: Habitat

Table F2—Habitat selection for foraging and roosting by spotted owls[a] (habitat descriptions for each study are summarized in table Fl)

Stand condition	Selection category	Oregon Coast Range and Klamath Mountains	Washington Cascades and Olympic Peninsula	
		A	B	C
Old growth	+	39/47[b]	5/10[b]	12/16[b]
	N	8/47	5/10	4/16
	—	0/47	0/10	0/16
Old with some mature and young	+	4/43		
	N	31/43		
	—	8/43		
Mature	+	0/20	2/10	1/14
	N	12/20	8/10	12/14
	—	8/20	0/10	1/14
Young	+	1/44	1/10	1/16
	N	24/44	8/10	14/16
	—	19/44	1/10	1/16
Pole/sapling	+	0/45[c]	0/10	0/16
	N	13/45	8/10	9/16
	—	32/45	2/10	7/16
Sapling	+	0/43		
	N	16/43		
	—	27/43		
Open canopy	+	0/10	0/16	
	N	6/10	9/16	
	—	4/10	7/16	
Clearcut	+	0/38		
	N	10/38		
	—	28/38		
Nonforest	+	0/16	0/10	0/16
	N	5/16	2/10	4/16
	—	11/16	8/10	12/16

[a] Numerators are numbers of birds in a category (+ = used more than expected; N = neutral, used in proportion expected; — = used less than expected); denominators are numbers of birds with that stand condition in their home range.
[b] Data in column A from Carey (pers. comm.), in column 8 from Hays et al. (1989b), and in C from Allen et at (1989).
[c] In this study, use of the pole/sapling category applied to poles only. Selection for saplings was calculated separately and is indicated below.

Table F3—Habitat selection by foraging spotted owls [a] (habitat descriptions for each study are summarized in table Fl)

Stand condition	Selection category	Oregon Coast [b] A	B	C	Oregon Cascades [c] D	E
Old growth	+	5/5	6/6	9/9	8/8	13/14
	N	0/5	0/6	0/9	0/8	1/14
	—	0/5	0/6	0/9	0/8	0/14
Mature	+	3/5	0/2	0/9	1/7	4/13
	N	2/5	1/2	6/9	3/7	8/13
	—	0/5	1/2	3/9	3/7	1/13
Young	+	0/5	1/6 [d]	0/7	0/5 [d]	0/l4 [e]
	N	0/5	1/6	1/7	3/5	0/14
	—	5/5	4/6	6/7	2/5	14/14
Pole/sapling	+		0/4 [f]	0/9	0/7 [g]	
	N		1/4	0/9	0/7	
			3/4	9/9	7/7	
Mixed ago	+	1/5		0/6		
	N	2/5		3/6		
	—	2/5		3/6		
Hardwood riparian	+	1/5	1/2	0/9	0/1	
	N	4/5	1/2	6/9	1/1	
	—	0/5	0/2	3/9	0/1	
Clearcut/grass/ shrub/other	+	0/5	0/6	0/9	0/6	
	N	0/5	0/6	1/9	0/6	
	—	5/5	6/6	8/9	6/6	

[a] Numerators are numbers of birds in a category (+ = used more than expected; N = neutral, used in proportion expected; — = used less than expected); denominators are numbers of birds with that stand condition in their home range.
[b] Column A is from Thrailkill and Meslow (1989); B is from Forsman et S. 1984); C is from Carey et 5. (1990).
[c] Column D is from Forsman et at, (1984); E is from Miller and Meslow (1989).
[d] In this study, several categories of young forest were evaluated. We presented results for stands that were 60 to 80 years old and 10 to 30 inches in d.b.h.
[e] Includes all other stands younger than mature, including clearcuts.
[f] Data presented for stands 25 to 35 years old.
[g] Data presented for stands 21 to 30 years old.

All studies that reported separate data on nesting habitat found strong selection for roosting in old-growth forests (table F4). In the Oregon Coast Range and Oregon Cascades, Forsman et al. (1984) found that >90% of all roosts were in old-growth conifer stands. In the Oregon Cascades and Coast Range, three studies (Carey et al. 1990, Miller and Meslow 1989, Thrailkill and Meslow 1990) found that all of the owls they studied *(n* = 27) roosted in old-growth forests significantly more than expected. Three other stand conditions were also used significantly more often than expected by a few birds—young stands with a mature/old-growth component (1 of 27 birds), mature (2 of 27), and hardwood riparian (1 of 27) (table F4). Twenty (74%) of the owls in the three studies roosted in mature stands in proportion to their availability. Young and pole/sapling stands with trees <20 inches in d.b.h. were used significantly less than expected for roosting by about 98% of the owls studied. Clearcuts and unforested areas were rarely used for roosting.

Table F4—Habitat selection for roosting by spotted owls[a] (habitat descriptions from each study are summarized in table Fl)

Stand condition	Selection category	Oregon Coast[b] A	Oregon Coast[b] B	Oregon Cascades[c] C
Old growth	+	4/4	9/9	14/14
	N	0/4	0/9	0/14
	—	0/4	0/9	0/14
Mature	+	0/4	0/9	2/11
	N	4/4	7/9	9/11
	—	0/4	2/9	0/11
Young	+	0/4	0/7	0/12[d]
	N	0/4	1/7	0/12
	—	4/4	6/7	12/12
Pole/sapling	+	0/9		
	N	1/9		
	—	8/9		
Mixed age	+	1/4	0/6	
	N	3/4	4/6	
	—	0/4	2/6	
Hardwood riparian	+	1/4	0/9	
	N	3/4	3/9	
	—	0/4	6/9	
Clearcut/grass/ shrub/other	+	0/4	0/9	
	N	0/4	1/9	
	—	4/4	8/9	

[a] Numerators are numbers of birds in a category (+ = used more than expected; N = neutral, used in proportion expected; — = used less than expected); denominators are numbers of birds with that stand condition in their home range.
[b] Data in column A are from Thrailkill and Meslow (1990); B are from Carey et al. (1990).
[c] Data in column C are from Miller and Meslow (1989).
[d] Includes all other stands younger than mature, including clearcuts.

Attributes of roost trees in the Oregon Cascades and Coast Range were described by Forsman (1980) and Forsman et al. (1984). They found that roost site selection was influenced by weather, with owls using large trees (d.b.h. 20 to 70 inches) in the forest overstory during cool or wet weather, and small trees in the forest understory during warm weather. Forsman et al. (1984) suggested that spotted owls prefer older forests because the layered structure of the canopy provided a range of roosting microenvironments.

In summary, for both roosting and foraging in Washington and Oregon, old-growth was the only stand condition that was used in greater proportion than its availability by a majority of owls, and it was never used less than expected. More than 60% of the owls studied were neutral in their use of mature stands (interpreted to be marginal habitat). Stands <80 years old were used by 96% of the owls either in proportion to or less than expected. Clearcuts and other nonforested areas were used significantly less than expected by most owls studied and more than expected by none.

Appendix F: Habitat

Studies at a Landscape Scale

Some studies suggest that spotted owls select areas from the general landscape that have higher concentrations of old-growth forest. Using the modified minimum convex home range as a basis for studying habitat selection patterns, Carey (pers. comm.) tested for landscape-scale habitat selection by comparing mean percentages of old growth (including mixed-aged old growth) within home ranges of owl pairs to the general landscape composition. In all five landscapes examined, old growth within the pairs' home ranges averaged 1.5 times the proportion of old growth in the general landscape. Selection for old growth was significant in four of the five landscapes. No other stand condition was overused by the population at the landscape scale (Carey, pers. comm.).

In the Washington Cascades, Allen et al. (1989) also compared percentages of stand conditions within home ranges with randomly located circles 2.1 miles in radius. On the Gifford Pinchot National Forest, both the mean percentage of old growth (dominant trees >30 inches in d.b.h., and codominants >16 inches in d.b.h.) and the mean percentage of old-growth and mature stands combined (dominant trees >20 inches in d.b.h.) within home ranges were significantly higher than in the surrounding landscape. On the Mount Baker-Snoqualmie National Forest, however, the difference between coverage of old growth in owl home ranges and the randomly selected circles was not significant.

Few studies have investigated the effects of habitat fragmentation on the spotted owl's habitat use. In the Washington Cascades, habitat fragmentation (expressed as the frequency of cover-type polygons per 0.6 mile) was not significantly different between home ranges and the surrounding landscape (Allen et al. 1989). In the Oregon Coast Range, Thrailkill and Meslow (1990) found no significant difference in fragmentation (expressed as habitat changes along transects) between nest locations ($n = 3$) and random locations.

Although the number of studies is small, some evidence indicates that habitat fragmentation may affect home-range size. In a study of 47 owls in the Oregon Coast Range and Klamath Province, Carey (pers. comm.) examined the effects of habitat fragmentation on home-range size in five study areas in two forest zones—western hemlock and mixed-evergreen/mixed-conifer. Using a variety of measures of fragmentation, he found that owls in areas with more clumped distributions of old-growth forest had smaller home ranges on average than owls in areas where old-growth forests were more fragmented.

Habitat Used for Nesting

General stand conditions have been described at nest sites in Oregon and the Olympic Peninsula in Washington by Forsman (1976, pers. comm.), Forsman et al. (1984), and Bown (pers. comm.). As was true for habitat selection by roosting and foraging birds, owls nested primarily in old-growth forests (table F5): 79% of 130 nests were located in old-growth stands, and 16% were in stands where old-growth, mature, and young trees were intermixed, or where old growth occurred in patches or as scattered trees. Only 6 of the 130 nests (4%) were found in mature or young stands (table F5).

Appendix F: Habitat

Most spotted owl nests in Oregon and on the Olympic Peninsula are in old-growth trees: 39 of 47 nests (83%) found in three physiographic provinces in Oregon were in trees >200 years old, 15% were in trees 100 to 200 years old, and one (2%) was in a tree that was only 80 years old (Forsman et al. 1984). Ages of nest trees on the Olympic Peninsula were unavailable, but Forsman (pers. comm.) found that all known nests were in large, very old trees or snags. An exception is the eastside Cascades of Washington, where most nest trees were 100 to 200 years old (58% of nests), 27% were in trees >200 years old, and 15% were in trees <100 years old, possibly as a result of the fire and logging history in the area (Irwin, pers. comm.).

In contrast to the predominance of platform nests on the east slope of the Cascades of Washington, all nests on the Olympic Peninsula and most nests in western Oregon were in tree cavities. In the mixed-conifer forests of the Klamath Mountains and on the east slope of the Cascades in Oregon, however, nests were about equally divided between cavities and platforms (Forsman 1976, Forsman et al. 1984).

Stand structure at 52 spotted owl nest sites on the Wenatchee and Okanogan National Forests in the Washington Cascades was measure by using nested plots in and around nest sites (Irwin et all 1989a) (table F6). Mixed-conifer was the dominant forest zone in both study areas. The average age of dominant overstory trees was 166 years, and the average age of intermediate dominants was 101 years. Douglas-fir was the dominant species accounting for 48% of the basal area. Mean live-tree basal area was 162 square feet per acre. The average nest site contained 14.9 tree per acre that were 21 to 36 inches in d.b.h., and 1.7 trees per acre >36 inches in d.b.h. Average basal area of snags was 25 square feet per acre.

The low basal area of trees at nest sites studied by Irwin et al. (1989a) reflects the fact that much of the study area had been subjected to a long history of fire and high-grade logging. Any of the large, overstory trees had been removed during selective logging operations. Although the stand still have multilayered canopies with relatively high closure, both the average size and basal area of trees were much lower in old-growth forests used for nesting in California (for example, see table F13). Past fires and logging in these areas, however, frequently left large numbers of old-growth trees that survived into the next stand of young trees. These remnant old trees are typically infected with dwarfmistletoe, and often contain debris platforms that result when raptors or arboreal mammals build nests in or among the dense clusters of deformed limbs.

These debris platforms supported 77% (41 of 53) of the nests, including 47% abandoned hawk nests and 30% mistletoe-broom nests. Sixty-six percent of all owl nests were in trees infected with dwarfmistletoe. Cavities and broken-topped trees were used in nest sites by only 19% (10 of 52) of the owls. Most nests (92%) were in Douglas-fir trees. Ages of nest trees determined from core sample ranged from 67 to 700 years ($\overline{x}$ = 194 years).

Table F5—Stand conditions at spotted owl neat sites in Oregon and the Olympic Peninsula of Washington[a]

Forest condition	Oregon[b] A	Oregon[b] B	Oregon Peninsula[c] C
Old growth	42/47	38/50	23/33
Old growth/ old growth scatter/ old growth patch		11/50	10/33
Mature	2/47		
Young	3/47	1/50	

[a] Numerators show nests in each forest condition; denominators show total sample.
[b] Data in column A from Forsman (1976) and Forsman et al. (1994); column B are from Bown (pers. comm.).
[c] Data in column C are front Forsman (p.m. comm.).

Table F6—Mean stand attributes at spotted owl nest sites in the eastern Washington Cascades, 1988 and 1989 (estimates based on 52 1/4-acre plots centered at nest sites)[a]

D.b.h. class in inches	Mean number of stems/acre	Basal area in ft^2/acre
Conifers and hardwoods[b]		
4.0 to 10.9	105.05	25.65
11.0 to 20.9	51.82	59.61
21.0 to 35.9	14.86	54.93
36+	1.65	22.32
Subtotal	173.38	162.51
Snags	27.80	24.90
Grand total	201.18	187.41

[a] Data are from Buchanan (pers comm.) and Irwin et al. 1989a.
[b] Hardwoods represent <1% of the total basal area (Irwin et al. 1989a).

Appendix F: Habitat

Other Information on Habitat Structure

Although most habitat-use studies of spotted owls in Oregon and Washington did not provide detailed measurements of stand structure, such studies are available for the general stand structure of old-growth, mature, and young forests within the range of the owl (tables Fl and F8) (Forsman et al. 1986; Spies et ai. 1988; Spies and Franklin 1988, in press). These studies were not designed to look at specific owl-use areas, but most old-growth sample plots were located in areas known to be pied by spotted owls (Forsman, pers. comm.). Consequently, we believe the standcondition data from these studies should provide guidance for silvicuitural prescuiptlons for producing superior habitat within the western hemlock and mixed-conifer zones in western Oregon and western Washington (for example, table F6). Addition studies on stand structure are needed in other provinces.

Table F7—Densities of trees (stems/acre) greater than 20 inches in d.b.h. in natural stands of Douglas-fir and western hemlock in the Oregon Coast Ranges and Olympic Mountains (data were based on 4 circular, 0.7-acre plots per stand; values are grand means for each stand condition)

D.b.h. class (inches)	Old –growth[a] stands (*n* = 26)	Mature stands[a] (*n* = 10)	Young-growth[a] stands (*n* = 13)
20 – 29.9	10.2	23.6	29.9
30 – 39.9	5.3	14.3	8.5
40 – 49.9	4.0	4.0	1.7
50 – 59.9	3.2	0.8	0.6
60 – 69.9	2.4	0.1	0.2
70 – 79.9	0.9	<0.1	0.0
80 – 89.9	0.3	0.0	0.0
90 – 100	0.1	0.0	0.0
Total	26.4	42.8	40.9

[a] Data are from Forsman et al. (1986). Stand ages were based on core samples and counts of annual rings on felled trees or stumps at stand edges. Old-growth stands were characterized by a dominant overstory of trees >200 years old, mature stands had dominant overstories 100 to 200 years old; and young-growth stands had overstory dominants 60 to 99 years old. All of these were unmanaged stands that had regenerated naturally after wildfires or other catastrophic events.

Table F8—Densities of trees (stems/acre) in young (40 to 79 years old), mature (80 to 195 years old), and old-growth (196+ years old) stands in western Oregon and western Washington (data from 5 1/4-acre circular plots per stand, and stand age was determined from core samples of dominant trees and from ring counts in adjacent clearcuts)[a]

	Oregon Coast Range			W. Oregon Cascades			W. Washington Cascades		
Species and d.b.hdass	Young (n = 6)	Mature (n = 10)	Old (n = 25)	Young (n = 18)	Mature (n = 25)	Old (n = 51)	Young (n = 13)	Mature (n = 16)	Old (n = 40)
Douglas-fir 39+ inches	0.4	3.6	12.1	0.0	2.0	10.1	0.4	0.8	6.1
All species 39+ inches	0.4	4.5	13.4	0.0	2.4	13.4	0.4	1.2	10.1
Douglas-fir 31.5+ inches	2.0	9.3	16.2	0.0	6.5	13.0	0.4	4.9	9.3
All species 30.5+ inches	2.0	10.9	19.0	0.4	7.7	19.4	0.4	6.1	19.0
Shade-tolerant[b] 16+ inches	5.7	10.5	13.0	5.3	4.9	20.2	1.2	15.0	30.0
Shade-tolerant[b] 10+ inches	18.6	26.7	27.9	28.3	12.6	36.4	15.0	36.4	47.0

[a] Data are from Spies (pers. comm).
[b] Shade-tolerant species include western hemlock, Pacific silver fir, western redcedar, grand fir, and white fir.

Table F9—Habltat selection by foraging and roosting spotted owls on the Six Rivers National Forest, California[a]

Forest condition	Selection category	A[b]	B[c]
Old-growth and mature mix	+	7/7	3/5
	N	0/7	2/5
	—	0/7	0/5
Pole/medium	+	0/7	2/5
	N	0/7	2/5
	—	7/7	1/5
Brush/seedling/ sapling	+		0/5
	N		1/5
			4/5

[a] Numerators are numbers of birds in a category (+ = used more than expected; N = neutral, used in proportion expected; — = used less than expected); denominators are numbers of birds with that stand condition in their home range.
[b] Data from Solis (1983).
[c] Data are from Sisco and Gutiérrez (1984).

Results of Habitat Studies in Northern California

Solis (1983) analyzed roosting and foraging habitat selection by seven owls in the Six Rivers National Forest in two stand types—mature/old-growth (d.b.h. >21 inches, >70 years old) and pole/medium (d.b.h. 5 to 20.9 inches, 15 to 70 years old).

Appendix F: Habitat

Characterization of Habitat Used for Foraging and Roosting

All owls used the old-growth/mature stands significantly more, and the pole/medium stands significantly less than expected (table F9). Although home ranges included 16 to 40% brush/sapling condition (d.b.h. <5 inches, 0 to 15 years old), only 2.3% of the observations occurred in this stand condition.

More recent studies on the Six Rivers National Forest (Paton and Bingham, pers. comm.) examined habitat selection at the landscape scale by 14 radio-marked pairs over a 3-year period in the Mad River (7 pairs) and Ukonom (7 pairs) areas. Landscape boundaries for each study area were delineated by a minimum convex polygon around the pooled locations of all owls in each area. The pooled locations for all owls in each study area were compared with the proportion of each stand condition within the pooled landscape.

At each study area, northern spotted owls showed significant, nonrandom use of stand conditions, both for foraging and roosting during breeding and nonbreeding seasons. Individual comparisons of use versus availability were not made, but 79% and 74% of the foraging locations on the Mad River and Ukonom areas, respectively, were in forests with dominant canopy trees >21 inches in d.b.h. The proportion of roosting locations in stands with overstory trees >21 inches in d.b.h. was 86% at Mad River and 81% at Ukonom. Until ground-based habitat analyses can be completed and integrated into the various analyses of habitat selection by spotted owls in these areas, however, results presented here must be considered incomplete.

Kerns (1989) examined habitat use by a sample of eight radio-marked owls in young forests of coastal redwood and Douglas-fir in northwestern California. Old-growth stands were almost entirely absent from the study area (<l% coverage). Not surprisingly, the owls foraged and roosted primarily in young forests or in selectively logged stands of young and mature trees because few other forest types were present from which to select. Descriptions of young forests provided by Kerns indicate that the young and mature stands on his study area frequently had multilayered, multispecies canopies of conifers and hardwoods with overstory trees 28 to 40 inches or more in d.b.h. These conditions are structurally similar to conditions attained only in relatively old forests in most areas of the range of the northern spotted owl. Although this study could be cited as an exception to the general rule that old-growth forests generally provide superior habitat for spotted owls, it actually reinforces our view that the structural attributes of owl habitat are critical (for example, multilayered, multispecies stands with large overstory trees). In most of the species' range, these conditions normally develop only in very old forests.

In northern California, spotted owls tend to use the same roost trees repeatedly throughout the summer. Although stand conditions were not designated by age-class Solis (1983) noted that owls selected roasts in stands with a two-layered canopy. Barrows and Barrows (1978) and Barrows (1981) hypothesized that spotted owls selected roosts in cooler microclimates in lower portions of the canopy to reduce stress.

Stand Structure: Foraging and Roosting

Two studies on the Six Rivers National Forest (Sisco and Gutiérrez 1984, Solis quantified habitat used by spotted owls for foraging and roosting in northwestern California (table F10). In both studies, the sample unit was a circular, 0.1-acre plot at or near roosting and foraging locations of radio-marked owls. Within the study area, Douglas-fir/tanoak/Pacific madrone was the most extensive forest type; white fir was dominant at elevations >4000 feet.

Appendix F: Habitat

Table Fl 0—Mean stand attributes in foraging and roosting sites used by spotted owls on the Six Rivers National Forest in 1980 to 1982[a] (data are from 723 0.1-acre plots)

D.b.h. class in inches	Mean number of stems/acre	Basal area in ft^2/acre
Conifers		
4.0-4.9	7.26	0.81
5.0-1 0.9	30.16	9.89
11.0-20.9	19.54	24.78
21.0-35.9	10.39	42.76
36.0+	11.16	155.71
Subtotal[b]	78.51	233.95
Hardwoods		
4.0-4.9	18.70	2.10
5.0-10.9	62.38	19.17
11.0-20.9	19.24	22.92
21.0-35.9	3.97	14.24
36.0+	0.51	5.67
Subtotal[c]	104.80	64.10
Total live	183.31	298.05
Snags	21.67	32.99
Grand total	204.98	331.04

[a] Data are from Sisco and (3utiárrez (1984) and Solis (1983).
[b] Tanoak constituted 60.33 trees per acre, 25.19 square feet per acre.
[a] Douglas-fir constituted 69.5 trees per acre, 216.3 square feet per acre.

Mean values for stand structures associated with foraging and roosting indicate that the owls used stands characterized by an overstory of moderately dense, large (d.b.h. >21 inches), live conifers, and an understory of moderately dense pole- to medium-sized trees (d.b.h. 5 to 20 inches, 15 to 70 years old) (table F10). Overstory/understory canopies were multilayered, with conifers averaging 0.5 to 2 times the hardwood height in trees ≥11 inches in d.b.h. (Sisco and Gutiérrez 1984). Douglas-fir was the predominant species in the overstory, with the understory dominated by hardwoods, primarily tanoak. Mean canopy closure in stands was 87% far summer locations and 80% at winter locations (Gutiérrez et al.1984).

Average density of snags was 22 per acre, and the average basal area of snags was 33 square feet per acre. Douglas-fir snags occurred most frequently (Sisco and Gutiérrez 1984, Salis 1983). Twenty-eight percent of the snags had been dead far <1 year; 24% had been dead from 1 to 5 years; and 48% had been dead >5 years. Dead, woody debris accounted for 8.6% of the ground cover (table F11).

Appendix F: Habitat

Table F11—Percentage composition of ground cover in stands used by spotted owls for foraging, roosting, and nesting in northwestern California (dead-and-downed woody material included fallen, dead, or dying woody debris on the forest floor)

Situation	Trees/shrubs <4 inches in d.b.h.	Shrubs	Herbs	Litter	Dead-and-downed wood[a] 1 to 12	Dead-and-downed wood[a] >12
Foraging and roosting[b]	35	8	9	92	6	2
Nesting[c]	22	9	13	75	10	5
Nesting[d]	27	1	7	78	5	3
Nesting[e]	11	9	16	78	16	2

[a] Diameters (in inches) are from the large end of a piece.
[b] From Sisco and Gutiérrez (1984) and Solis (1983); *n* = 723 0.1-acre vegetation plots.
[c] In Douglas-fir/tanoak stands; data from one plot on each of the four cardinal compass directions 82 feet from the nest tree; *n* = 32 nests (LaHaye 1988).
[d] In mixed-conifer stands; data from one plot on each of the four cardinal compass directions 82 feet from the nest tree; *n* = 6 nests (LaHaye 1988).
[e] In redwood stands; data from one plot on each of the four cardinal compass directions 82 feet from the nest tree; *n* = 6 nests (LaHaye 1988).

Stand structure differed between roosting and foraging sites. Canopy closure, stem density, and basal area for both old-growth conifers >35 inches in d.b.h. and all hardwoods were greater in roosting habitats (Gutiérrez et al. 1984, Sisco and Gutiérrez 1984, Solis 1983). Summer roosting habitat had the highest density and basal area of large conifers (d.b.h. >35 inches; 16.4 stems per acre, 215 square feet per acre) and the highest canopy closure (92.8%) (Solis 1983). In a study an the Klamath National Forest (Asrow 1983), stand attributes were estimated in roost areas and areas of “intensive use,” but these designations were not accompanied by comparisons of proportional use in different stand types (table F12). The data provide additional insight into the structure of stands frequented by spotted awls in mixed-conifer forests in northern California.

Habitat Used for Nesting

LaHaye (1988) determined the stand structure of 44 nest sites in three forest types in northwestern California (table F13): redwood/California bay (*n* = 6), Douglas-fir/tanoak (*n* = 32), and mixed-conifer (*n* = 6). Stand structure was measured at variable plots located at the nest and at 82, 492, and between 656 and 4920 feet from the nest for each of the four cardinal compass directions. Here, we report results only from plots 82 feet from the nest (on the four cardinal compass directions) as most representative of conditions in the immediate nest stand. Results were similar to those for foraging and roosting locations an the Six Rivers National Forest. Spotted owls nested in habitats dominated by old-growth conifers (d.b.h. >35 inches) with an understory dominated by hardwoods. Canopy closure in nest stands ranged from 81 to 82% in the three forest types.

Spotted owls nested primarily in old-growth Douglas-fir (57 of 69 nests = 83%) (LaHaye 1988). Ages of 50 nest trees determined from core samples ranged from 57 to 688 years; 35 (70%) were >200 years old. Forty-one of the nests (60%) were in cavities in the taps of broken-topped trees, 14 (20%) were in cavities elsewhere in the trunk, and 14 were on platforms, including abandoned goshawk or Coopers hawk nests or natural accumulations of debris.

Table Fl 2—Mean stand attributes in "intensive use" and roost areas from 4 SOHAs on the Klamath National Forest (5 variable-radius samples were taken at six plots each in the stands, means were computed for each stand) [a, b]

D.b.h. in inches	Stems per acre	Basal area	Tree ages[c]	
			Mean	Range
Conifers				
1-10	154.0	31	73	64-79
11-17	33.3	38	97	87-110
18-29	19.9	60	146	130-178
30+	9.5	79	250	21 0-367
Subtotal	216.7	208		
Hardwoods				
1-10	14.3	4.5		
11-17	3.0	3.0		
18-29	0.4	1.0		
30+	0.0	0.0		
Subtotal	17.7	8.5		
Total live	234.4	216.5		
Snags				
1-10	5.6	5.0		
11-17	2.7	3.5		
18-29	8.1	8.3		
30+	7.3	8.0		
Total dead	23.7	24.8		
Grand total	258.1	241.3		

[a] Tabled values are grand means of the four SOHAs basal areas in square feet per acre.
[b] Data are from Asrow (1983).
[c] Numbers of core samples taken on trees were large and differed between d.b.h. classes. Mean age was determined from basal-area weighted average. Because sample sizes cannot be ascertained at this time, values should be considered reasonable estimates only on an ordinal scale.

Appendix F: Habitat

Table F13—Mean basal area (ft^2/acre) and other site attributes in different forest stand types used for nesting by northern spotted owls in northwestern California (data are based on 4 variable-radius plots on the 4 cardinal compass direction 82 feet from the nest trees) [a, b]

D.b.h. class in inches	Douglas-fir/ tanoak stands (*n* = 32)	Mixed-conifer stands (*n* = 6)	Redwood/ Calif. laurel (*n* = 6)
Conifers			
0.4-12	27	91	23
12-24	18	41	58
24-35.4	33	42	73
35.4+	133	94	59
Subtotal	211	268	213
Hardwoods			
0.4-8	33	12	33
8-16	48	19	43
16-24	27	3	18
24+	18	6	5
Subtotal	126	40	99
Grand total	337	306	312
Mean canopy cover *(%)*	81	81	82
Mean elevation (ft)	2572	4261	574
Mean slope *(%)*	49	40	42

[a] Tabled values include both live trees and snags.
[b] Data are from LaHaye (1988).

In 1989, nesting was documented at 41 sites on privately owned lands in northern California (Irwin et al. 1989b: Kerns 1988, 1989; Pious 1989). Only four of the nesting pairs were in stands >80 years old. In Pious' (1989) work and some of Diller's (1989) surveys in young redwood forests, data indicated a trend of greater occupancy by pairs in stands dominated with redwoods >60 years old, when compared to data from stands primarily younger than 60 years. These trends were not statistically significant.

Parts of the areas surveyed (for example, coastal redwood) contained highly productive growing sites, which may explain the relatively high number of nest sites in relatively young forests. The comparatively high site productivity of coastal areas was probably reflected in data of Irwin et al. (1989b) showing that spotted owl responses per mile of transect surveyed were over 50% more frequent in young coastal redwood and redwood/Douglas-fir forests than in interior mixed-conifer and Douglas-fir forests. Furthermore, 75% of the 28 pairs producing young in 1989 in the study by Irwin et al. were found in the coastal forests.

Appendix F: Habitat

Table Fl 4—Average densities of trees (stems/acre), snags, and logs (pieces/acre) in young (40 to 100 years old), mature (101 to 200 years old), and old-growth (>200 years old) Douglas-fir/hardwood stands in northwestern California and southwestern Oregon (data f mm five 1/4-acre circular plots per stand; stand age was determined from core samples of dominant trees and from ring counts in adjacent clearcuts)[a]

D.b.h. class	Young[b] (n = 14)	Mature[b] (n = 14)	Old (n = 28)
Conifers 36+ inches	0.4	5.5	11.7
Hardwoods 36+ inches	0.1	0.2	0.4
Conifers 18-35 inches	12.6	23.0	8.8
Hardwoods 18-35 inches	8.9	4.7	8.3
Conifers[c] 2-17 inches	203.0	94.7	30.3
Hardwoods[d] 2-17 inches	345.2	206.4	228.0
Snags[e] 4+ inches	36.1	34.7	12.9
Logs[f] 4+ inches	168.9	121.8	124.6

[a] Data are from B. Bingham (pers. comm).
[b] All young and half of the mature stands originated after logging.
[c] Douglas-fir dominated all stands. Minor conifers included redwood, Port-Orford-cedar. western redcedar, ponderosa pine, sugar pine, and incense-cedar.
[d] Hardwoods included tanoak, madrone, canyon live oak, giant chinkapin, California-laurel, California black oak, and Oregon white oak.
[e] Snag diameter measured at breast height or top diameter for snags less than 4.5 feet tall.
[f] Log diameter measured at large end.

Other information on Habitat Structure

Bingham and Sawyer (in press) described the structure of young, mature, and old-growth Douglas-fir/hardwood forests in the Klamath and northern California Coast Range provinces (table F14). Although their study was not intended to evaluate owl use, as in Oregon and Washington (Spies and Franklin, in press), sample plots were located in stands occupied by owls. Numerous samples were from the Northern California Coast Range Preserve in stands known to be used by owls for more than 10 years, and on the Six Rivers National Forest in stands that have been or are currently included in owl studies. We believe that the stand condition data from their study should provide guidance for silvicultural prescriptions for producing superior owl habitat within the mixed-evergreen zone of northern California.

Appendix F: Habitat

Habitat in the Sierra Nevada

Recently, several pairs of California spotted owls have been found nesting in or neat riparian habitats in canyons at elevations ranging from about 1000 to 3000 feet in foothill woodlands of the western Sierra Nevada, east of Fresno (Neal et al. 1990). Tree-canopy closure commonly exceeds 70% in these sites, with stands composed of mixtures of interior live oak, California sycamore, California buckeye, and blue oak. Some very old trees occur, and sycamores often exceed 21 inches in d.b.h. Shrubs and smaller trees provide multilayered canopies, and considerable space beneath the canopy provides open flight space for the owls. Decadence is common in the form of dead-and-downed woody material, dead trees and limbs, and natural cavities in the trees. Dusky-footed woodrats comprise over 80% of the diet of owls in this area. These foothill woodland habitats are similar to woodland riparian areas in the southern part of the State, where California spotted owls have long been known to breed. Although breeding in these habitats is thus far known only in the range of the California subspecies, some areas in the Klamath Province (within the range of the northern spotted owl), particularly in the foothills bordering the Sacramento Valley, may provide similar habitat. These areas need to be surveyed to learn whether spotted owls are breeding there as well.

Discussion

With the exception of recent studies in the coastal redwoods of California, all studies of habitat use suggest that old-growth forests are superior habitat for spotted owls. Throughout their range and across all seasons, spotted owls consistently concentrated their foraging and roosting in old-growth or mixed-aged stands of mature and old-growth trees. For nest sites, owls used primarily old-growth trees, whether in old-growth stands or in remnant old-growth patches. Exceptions were found, but even they tended to support the usual observations that spotted owls nested in stands with structures characteristic of older forests. For example, although many of the nests described by Irwin et al. (1989a) on the east slope of the Washington Cascades were in mature stands that had been logged or burned in previous years, most nests were in remnant trees >100 years old. Furthermore, many of the remnant trees in these stands were characterized by heavy infestations of dwarfmistletoe, which provided nest and roost sites.

Structural components that distinguish superior spotted owl habitat from less suitable habitat in Washington, Oregon, and northwestern California include: a multilayered, multispecies canopy dominated by large (>30 inches in d.b.h.) conifer overstory trees, and an understory of shade-tolerant conifers or hardwoods; a moderate to high (60 to 80%) canopy closure; substantial decadence in the form of large, live coniferous trees with deformities—such as cavities, broken tops, and dwarf mistletoe infections; numerous large snags; ground-cover characterized by large accumulations of logs and other woody debris; and a canopy that is open enough to allow owls to fly within and beneath it.

Appendix F: Habitat

In the conifer-dominated forest zones where the northern spotted owl occurs, succession from an even-aged young stand to a multilayered canopy with decadence may take 150 to 200 years. A significant exception is the coastal redwood zone of northwestern California, where stands can attain old-growth structural attributes within 50 to 60 years after harvest. This ability is attributable to a unique set of conditions in that region: a rapidly growing tree species with stump-sprouting capability, early intrusion of other conifer species and several hardwood species into the understory, of relatively high rainfall and frequent fog, a long growing season, and an abundance of the dusky-footed woodrats, a common prey species of northern spotted owls where available (appendix J).

Given the conditions found in the coastal redwood zone, apparently most or all structural attributes of forest stands typically associated with the occurrence and breeding of spotted owls develop at an accelerated rate—perhaps attaining suitable conditions for spotted owls in as few as 50 to 60 years on some sites and superior conditions in 80 to 100 years. Because these conditions do not occur in most areas within the range of the northern spotted owl, we caution strongly against applying results from the California coastal redwood zone to all other parts of the range of the northern spotted owl.

Several possibilities might explain why spotted owls select forests with old-growth structure. For foraging, such forests may have higher densities of preferred prey; studies on prey abundance, however, have not consistently supported this hypothesis (see appendix J). Another possibility is that the owls are able to forage more efficiently in old stands because of the openness of the individual canopy layers and the range of foraging perches from near-ground height to the upper canopy.

Selection of old stands for nesting is most likely related to the high availability of suitable nest trees in such stands. Unless they contain remnant old-growth trees, young stands generally provide few suitable nest sites. Selection for roosting in old-growth stands may be related to thermoregulation. Barrows (1981) and Forsman et al. (1984) reported that spotted owls tend to roost in small trees in the forest understory during warm weather and high up in large trees during cold or wet weather. The layered canopy structure in old forests provides both types of roasts, whereas even-aged stands tend to include one roost type but not the other.

Although selection of old forests by spotted owls was relatively consistent among studies, considerable use of mid-aged and young stands also occurred. This use suggests that, as forests develop along the continuum from young to old, they gradually become more suitable for spotted owls. At the same time, the structural components typical of old growth are sometimes found in young forests, especially those that have regenerated from early disturbances (fire, wind, inefficient logging, and so on) that left behind large trees, snags, and logs from the earlier stands.

Appendix F: Habitat

Recommendations for Future Studies and Management

Questions to be Addressed

Detailed information on stand structure is still needed for many of the forest types inhabited by spotted owls. Given the considerable confusion regarding the characterization of stand conditions based on stand age, we recommend that future studies of habitat use by spotted owls provide detailed information on stand structure. Such information should include tree densities and basal area by d.b.h.-class and species, canopy closure, and occurrence of trees and snags with large cavities, broken tops, dwarf mistletoe infections, and other indications of decadence.

The full range of suitable habitats for spotted owls in California has not yet been determined, although much is known. Current FS guidelines for spotted owl habitat in northern California (Simon-Jackson, pers. comm.) specify multilayered stands of mature timber, with ≥70% canopy closure, at least 40% of that in trees ≥21 inches in d.b.h., and with obvious decadence (for example, many snags, including some large ones; broken-topped trees; logs and other woody debris on the ground). Because many owls in California occupy areas where relatively little suitable habitat occurs as defined by current FS guidelines, the adequacy of these guidelines is open to question.

For example, in the Klamath Province only 35.4% of all established SOHAs (n = 257) have at least 1000 acres of suitable habitat as characterized in Regional and Forest guidelines, and many SOHAs have fewer than 500 acres of suitable habitat. In spite of the fact that many SOHAS in these Forests have fewer than 1000 acres of "suitable" habitat, 95% of the monitored SOHAs (n = 60 in 1988, n = 66 in 1989; randomly drawn) were confirmed to have owls in 1989, and 97% had owls in 1988 or 1989. For sites with pairs, the respective values were 58 and 80%. For pairs with young, they were 46 and 80%, and for total SOHAs with young, the values were 23 and 58%. In three of the six SOHAs with less than 100 acres of suitable habitat, breeding occurred at least once in 1987,1988, or 1989. Two of the six had known pairs in at least 1 of the 3 years, and one had no birds detected in any of the 3 years. These findings indicate that the definition of suitable habitat either is not adequate or that the amounts of suitable habitat required may differ locally. Additional long-term studies are needed to further evaluate both the types and amounts of habitats required to support pairs of owls in northern California.

Outside of the HCAs, we recommend that future silvicultural treatments, experiments, and other habitat management practices in managed forests emphasize producing and maintaining the vegetational and structural components of superior spotted owl habitat (see appendix S). For example, in mixed-conifer and conifer/hardwood forests of northern California, and on the east slope of the Washington Cascades, breeding spotted owls have been located on lands where historical timber harvesting activity emphasized overstory removal or other partial-cutting techniques that retained relatively high canopy cover. We believe this practice, where feasible, has potential for extending the life of a timber stand for use by spotted owls. Similarly, we recommend that forest managers enhance the suitability of selectively logged areas by leaving either single old-growth trees or patches scattered within logged stands.

Results of the nesting study on the east slope of the Cascades in Washington (Irwin et al. 1989a) suggest to us that control of forest pathogens such as dwarf mistletoe may be detrimental to spotted owls and other raptors, especially in areas where large trees with cavities are not available as alternative nest sites. One way to test this relationship would be to remove trees infected with dwarf mistletoe from a sample of nest sites and see if those sites continue to be used for nesting. Nest boxes could be placed in experimental stands to test their suitability as substitutes for dwarfmistletoe platforms. In addition, studies should be designed to determine if the removal of trees infected with dwarf mistletoe affects the abundance of flying squirrels—the main prey of spotted owls on the east slope of the Cascades in Washington (see appendix J). Until such studies have been done, however, we recommend against the wholesale removal of trees infected with dwarf mistletoe from forests stands on the east slope.

And, finally, we recommend that future surveys for spotted owls be designed to determine the relative abundance of owls in all forest zones and stand conditions within the range of the owl.

Management of Habitat Within HCAs

Given the current distribution of old forests, we see no alternative in the short term but to protect significant amounts of the remaining superior habitat for northern spotted owls through the creation of HCAs. Under the conservation strategy proposed here, most logging activities within HCAs would cease. The ultimate management goal within HCAs, therefore, is to recreate a relatively unfragmented, natural landscape. This strategy will ultimately maximize the amount of superior habitat and minimize the amount of marginal and unsuitable habitat.

Until we can demonstrate that silvicultural treatments can benefit spotted owls, natural succession will be the primary means to achieve an unfragmented landscape within HCAs. In the long-term, we hope that silviculturists, foresters, and wildlife biologists will be able to work interactively to develop techniques that produce suitable habitat within the managed forest and make the HCAs unnecessary.

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G

Relative Abundance of Spotted Owls in Young, Mature, and Old Forests

Introduction

Studies that have investigated spotted owl occurrence in forests of different ages cannot be easily compared because researchers used different methods and worked towards different objectives. Particularly important for this comparison is the fact that the ages of sampled stands were not based on a fixed standard. Some researchers grouped stands by age-class, but not everyone used the same grouping intervals. Some researchers also did not specify stand ages, relying instead on an estimate of successional stage as an index to age. Finally, few studies were confined to extensive tracts of relatively even-aged forest, so most sampled tracts contained at least some mixing of patches of different ages. Because of these factors, we cannot give unambiguous definitions of young and mature forests. Generally, however, "old growth" was consistently used to mean stands where the dominant canopy was at least 200 years old.

Because of these problems, we caution readers against comparing results between different studies. Our objective in this summary was to determine whether the studies are consistent in suggesting a correlation between spotted owl abundance and forest age. The most useful studies are those in which the same observers, using the same sampling procedures, compared spotted owl abundance between samples from southwestern Washington and parts of the Olympic Peninsula and Washington Cascades, and between samples from northwestern Oregon and extensive stands of older forests to the south, in the Oregon Coast Range.

These comparisons seek to determine when forests regenerating from clearcuts first begin to develop attributes that support breeding pairs of spotted owls. Forests in predominantly second-growth condition, where the owls are breeding in the eastern Cascades of Washington and in parts of northern California, are not germane to this question. They are examples of how selective logging that left some old-growth attributes in stands has apparently maintained conditions suitable for breeding spotted owls.

Summary of Relevant Studies

Forsman et al. (1977)

Sample areas (fig. G1) were surveyed using the "leapfrog" method, in which observers called and listened for responses as they walked slowly along roads or trails (Forsman 1983). Surveys began on 12 July and ended on 11 August 1976. They were concentrated in stands <80 years old and stands >200 years old, because no extensive stands could be located in the intervening age group. This survey was designed to determine relative abundance of spotted owls, not total numbers or densities.

Appendix G: Owl Abundance

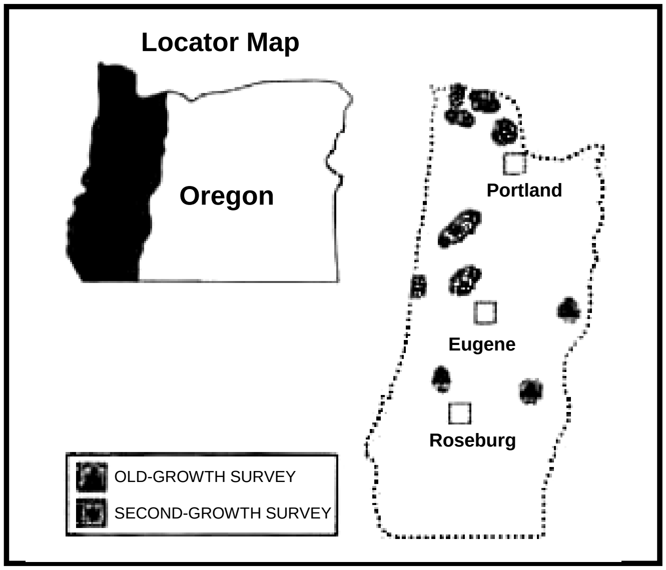

Figure G1—General survey areas sampled by Forsman et al. (1977).

Table G1—Detection rates of spotted owls on survey routes in western Oregon in 1978 (Forsman et al. 1977)

Age of stands	Miles surveyed	Pairs located	Singles located	Owls per mile
Younger forests (north Coast Range)				
20-35	20	0	0	0
36-45	64	1	3	0.08
46-60	11	0	1	0.09
61-80	9	0	0	
Older forests (central Coast Range, central Cascades)				
200+	29	10	7	0.93

Results—In their analysis, Forsman et al. (1977) assumed that any response represented a pair of spotted owls. They now feel, however, that this was an incorrect approach, because it assumes equal proportions of paired versus single owls in all forest types (Forsman, pers. comm.). For this reason, we reanalyzed their data using actual numbers of individuals responding per mile of transect surveyed (table G1). The difference between detection rates in young and old stands was significant (P <0.001; Mann-Whitney U test) (table G1).

Only one pair was located in young forests; the four other responses in young forests were all from single owls. Two of the five sites where owls were boated in young forest were near small, remnant patches of old growth. Another site with apparently good growing conditions (trees 42 to 45 years old were 30 to 36 inches in d.b.h.) also had pockets of forest 90 to 100 years old.

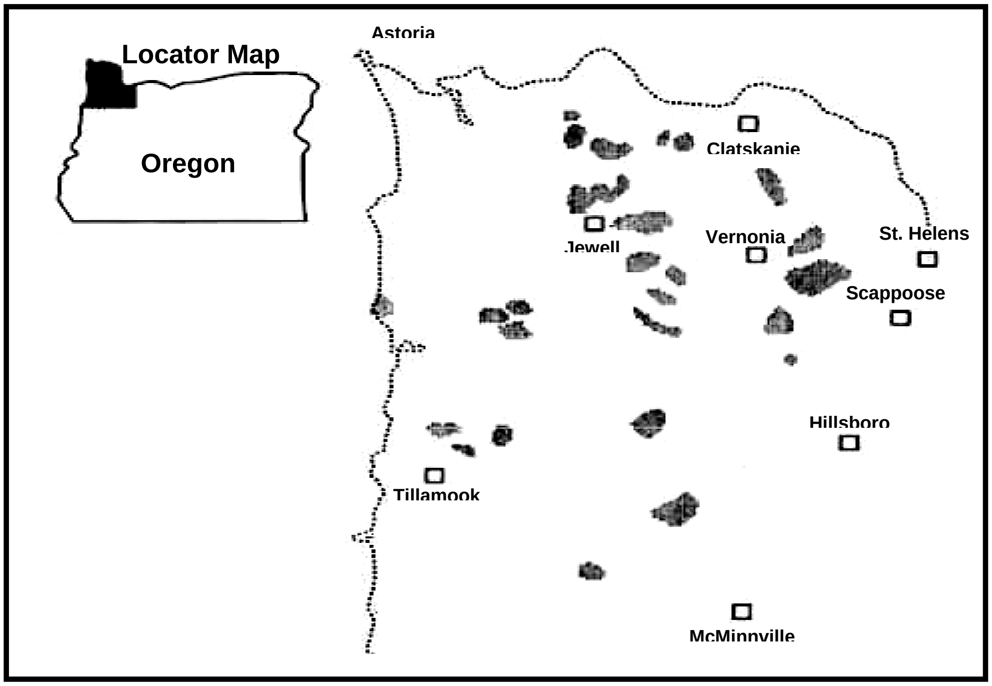

Figure G2—General survey areas sampled by Forsman (1988).

Searching for broods was not intensive, but two were found in old growth. No broods were found in young forests.

Forsman (1988)

Observers at sample locations (fig. G2) surveyed along roads, and stopped at 0.2-mile intervals to play recordings of spotted owl calls for at least 5 minutes at each station. Surveys began on 31 March and ended on 21 July 1986—10 years after surveys were done in the same areas in 1976 (Forsman et al. 1977). Some areas inaccessible by road or trail were surveyed by calling for 10 to 30 minutes from one or more vantage points overlooking canyons. When possible, daytime searches were made to locate owls found by nighttime surveys. Survey routes were systematically chosen to place them in forested habitat as uniformly as possible throughout the study area. Routes were intentionally chosen to traverse the oldest and most extensive forests present in a given area. “Mature” (110 to 140 years of age) and “old-growth” (200+ years old) stands were pooled for analyses because of small sample sizes. As in the study by Forsman et al. (1977), the objective was to obtain an index of abundance, not to determine the total number or density of owls.

Results—Spotted owls were found in two mature/old-growth stands (response rate = 0.06 individuals per mile; 29 miles surveyed). Both stands where owls responded were dominated by overstory trees 110 to 140 years old and contained residual old-growth trees. Two recently fledged young were found at one of these sites. In younger stands (46 to 64 years old), spotted owls were located at five sites (response rate = 0.03/mile; 151 miles surveyed). Most trees in these stands were 10 to 30 inches in d.b.h., but overstory trees 30 to 40 inches in d.b.h. were not uncommon on good growing sites. No evidence of nesting was found in any young stand, and all responses in young stands were from single birds.

Appendix G: Owl Abundance

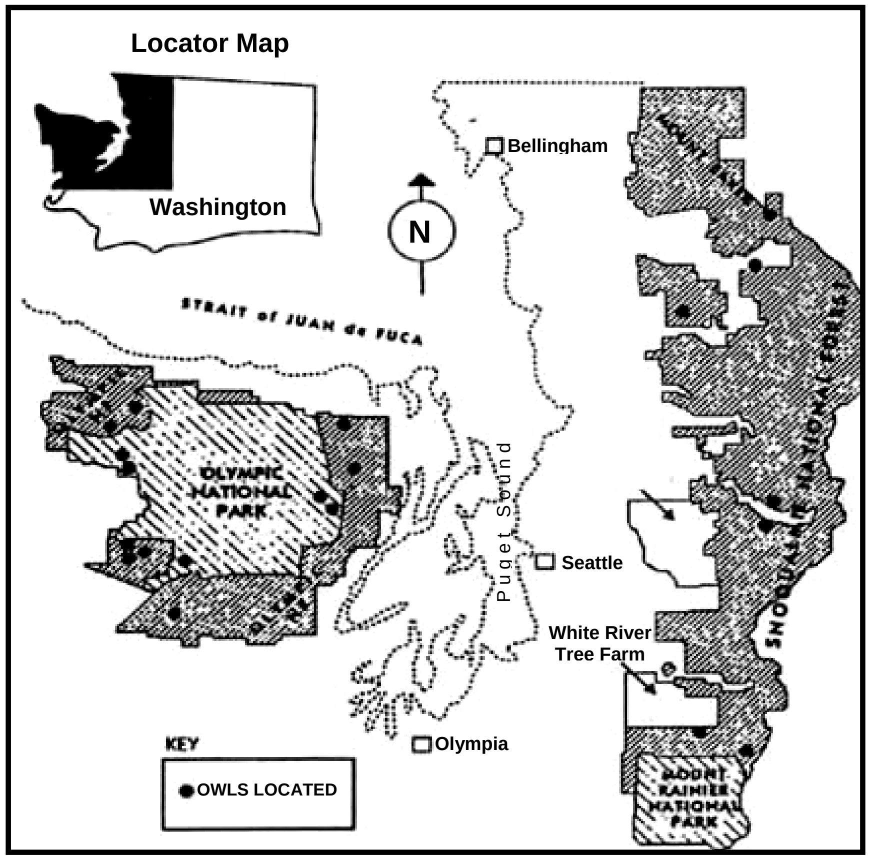

Figure G3—Owl sightings by Postovit (1979).

Results of this survey agree with those in Forsman et al. (1977), except that the response rate in younger forests was even lower than during the earlier survey. Again, this response rate suggested low abundance of spotted owls in young forests of the northern Coast Range of Oregon. Some sites with owls in 1976 (Forsman et al. 1977) also contained spotted owls in 1986 (Forsman, pers. comm.). The authors suggested that the low response rate in the older forests of the northern Coast Ranges may be attributable to their isolation from spotted owl population centers in more extensive stands of old forest.

Postovit (1979)

Sampling areas (fig. G3) were on routes that passed through stands of unharvested old forest, mosaics of old and young forest, and unbroken young forest. Old-growth stands were at least 120 years old, and most had overstory trees older than 200 years. Younger forests were less than 120 years old, and most were less than 70 years old. Routes were chosen randomly from township, range, and section data. Thirty 2-mile routes were surveyed in each of five landscape types (see footnote to table G2 for descriptions). Recorded calls and vocal imitations were broadcast a prescribed number of times at prescribed intervals along the routes walked.

Results—Spotted owls were found on 18 of the 150 routes—single birds on 14 routes and two birds on each of 4 routes (two cases confirmed as pairs), for a total of 22 birds. Pairs were located only in landscape types 1 and 2, which consisted of at least 66% older forest (table G2).

Table G2—Detection rates of spotted owls along randomly selected routes in landscapes with different proportions of old forest in Washington (60 miles of transect in each forest class) (Postovit 1979)

Landscape type[a]	Total count	Mean number per route	Owls per mile of transect
1	8	0.27	0.052
2	7	0.23	0.045
3	4	0.13	0.026
4	2	0.07	0.013
5	1	0.03	0.006

[a] 1 = >95% old forest, <5% young forest; 2 = 66 to 95% old forest 5 to 34% young forest; 3 = 33 to 65% old forest, 35 to 67% young forest; 4 = 5 to 32% old forest, 68 to 95% young forest; 5 = <5% old forest, >95% young forest.

Detection rates in landscape types 1 (>95% old forest) and 5 (<5% old forest) were significantly different ($X^2 = 4.04$; $P < 0.05$), and the mean number of owls responding per route was positively correlated with the proportion of the landscape in older forest (Spearman's rho = 1; 0.02 P >0.01).

Irwin et al. (1989)

Observers at sample areas (fig. G4) called at 0.3-mile intervals on road transects, using recorded and vocal calls, for 7 to 20 minutes at each calling station. Although an objective of the study was to sample stands mostly 40 to 120 years old, observers were unable to find extensive tracts in that age group. Reanalysis of the survey tracts indicated that an average of 86% of the area was <60 years old (Irwin, pers. comm.). Only the Matlock area contained much forest >60 years old. Altogether, this area had 20,000 acres of forest (34% of the total) 61 to 80 years old (not contiguous). Areas sampled were in relatively unfragmented forest stands of at least 10,000 acres; a few stands contained snags and scattered large trees.

Results—The study produced no conclusive evidence of breeding anywhere in seven township-sized survey tracts in southwestern Washington in either year. In one instance in the Matlock area, however, observers heard what they believed to be a juvenile spotted owl in 1987. Barred owls were not detected in the area, and adult spotted owls were found on several occasions (table G3).

The study included more effort per stop than in other Washington studies, but generally had lower detection rates (see table G3).

The Nemah-Naselle area had at least five spotted owls in early 1986 (Atkinson, pers. comm.). This area had a block of about 250 acres of old-growth forest, which contained a pair of spotted owls, but it was 30 miles from the nearest known population of spotted owls.

Observers found no evidence to support the hypothesis that site occupancy would increase with decreased distance from a major source population in an area of extensive old-growth forest. The sample sizes (number of birds per site), however, were inadequate for any such test.

Appendix G: Owl Abundance

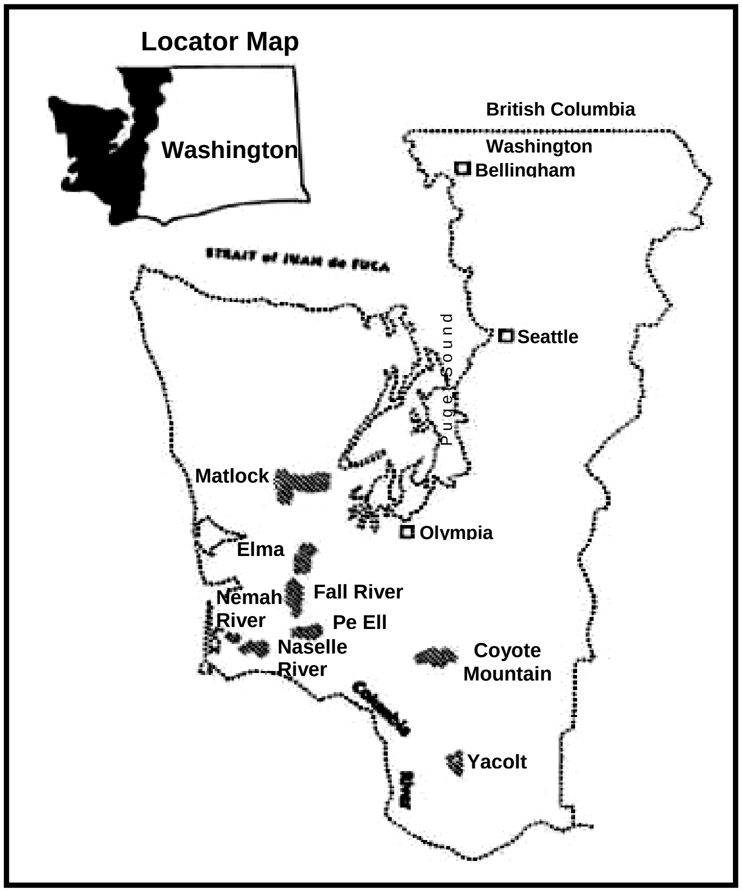

Figure G4—Study areas sampled by Irwin et al. (1989).

Table G3—Detections of spotted owls in forests mainly 20 to 60 years old in southwestern Washington (Irwin et al. 1989)

	1987				1988			
Location	Miles	Stops	Pairs	Singles	Miles	Stops	Pairs	Singles
Matlock	62.1	622	1	3	188.5	1237	0	0
Elma	71.8	690	0	1	60.6	409	1	0
Nemah-Naselle	26.4	132	1	1	23.5	156	0	0
Fall River					63.2	435	0	1
Pe Ell					46.2	340	0	0
Coyote Mtn.					99.2	651	0	0
Yacolt					17.0	253	0	0
Total	160.3	1444	2	5	498.2	3481	1	1
Birds/stop		0.006				0.0009		
Birds/mile		0.06				0.006		

Hays et al. (1989)

The design of this study involved random selection of 47 transects in western Washington, from the coast into the eastern Cascades. Each transect included 40 counting stations at 1/2-mile intervals (fig. G5). “Virtually all forested vegetative zones…in western Washington and the eastern Cascade Range were surveyed. Elevations of calling stations ranged from sea level to over 6,000 ft.”

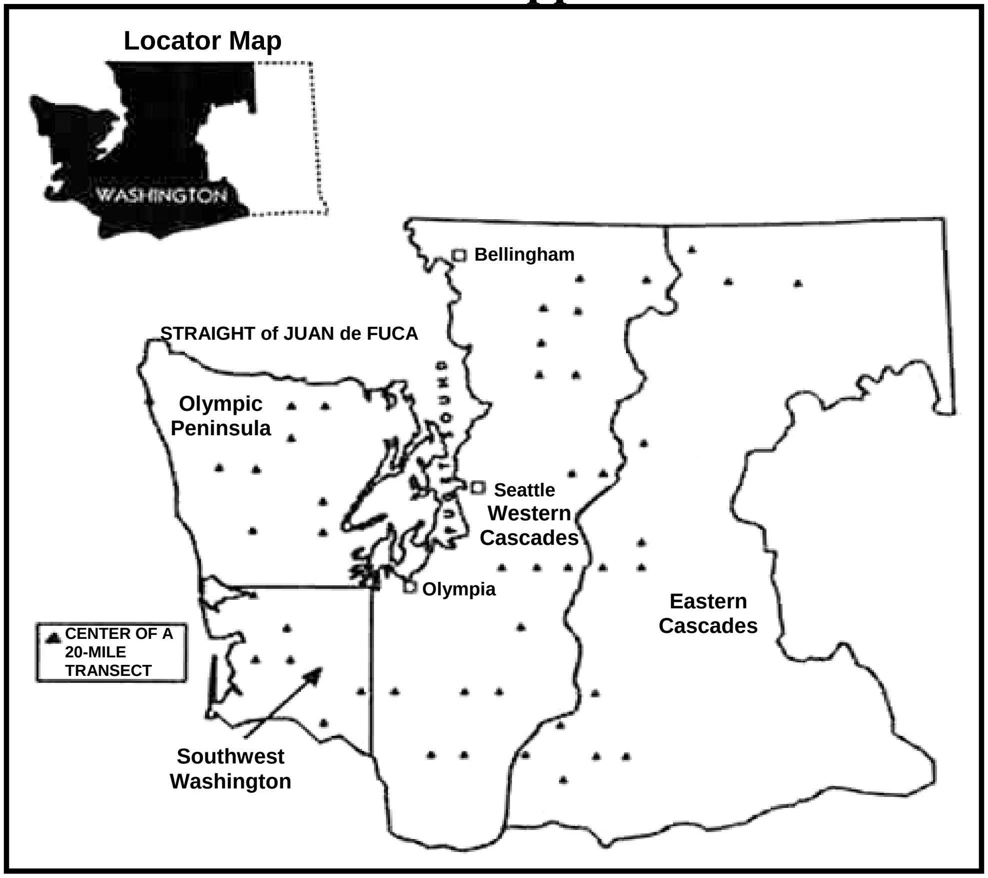

Figure G5—Centers of 20-mile transects sampled by Hays et al. (1989).

Estimates of habitat types were made over a 1/4-mile radius from each survey station. In addition, a subsample of 52 calling stations was randomly drawn from 22 transects. Vegetation based on Landsat imagery was characterized in a 2-mile square centered on each calling station in the subsample.

At each station, alternating tape-recorded and vocal calls were given for 7 to 10 minutes. When an owl was detected at a station, the surveyor skipped the next 1/2-mile stop to reduce the likelihood of double counting. Surveys were done twice in 1982 and twice in 1983, but not all transects were sampled every time because of a shortage of volunteers.

Results—Spotted owls were detected at 106 different calling stations; these counts were judged to represent 60 different single birds and nine pairs (table G4).

Routes in southwest Washington had the least old growth, as well as the lowest percentage of large sawtimber, based on the 1/4-mile-radius plots centered on counting stations. This area also had more than twice the amount of closed sapling-and-pole habitat than any other area.

Fourteen transects were in forests with less than 10% old growth (all six of the transects in southwest Washington and eight in other parts of the State). In a cumulative total of 1674 visits to 561 calling stations along these transects, over 2 years, only two birds were detected (0.0012/visit; 0.0023/mile of transect).

Table G4—Detection rates of spotted owls on randomly selected routes in forests of various ages throughout western Washington (Hays et at. 1989)

	Olympic Peninsula	Western Cascades	Eastern Cascades	Southwest Washington	Total
Number of transects	9	18	14	6	47
Total miles	585	1089	886	367	2927
Stations with responses	28	56	20	2	106
Responses/mi	0.05	0.05	0.02	0.005	0.037
Percentage of oldgrowth [a]	25	17	7	0	12
Percentage of large sawtimber	9	15	23	7	14
Percentage of young forest	35	33	58	72	53

[a] Percentages are based on samples from plots with a radius of 1/4 mile centered on each calling station.

Table 05—Detection rates of spotted owls along survey routes in the Gifford Pinchot National Forest (Paz et al. 1979)

Year	Stand age (years)	Miles of survey	Owl sites located	Owl sites per mile
1978	0-80	6.50	2	—[a]
	80-200	34.25	8	0.23
	200+	85.25	10	0.12
Total		126.00	20	0.16
1979	0-80	45.30	3	0.07
	80-200	166.10	14	0.08
	200+	131.20	22	0.17
Total		342.60	39	0.11

[a] Inadequate sample to estimate detection rate.

Based on results from the 52 randomly selected calling stations (32 stations where spotted owls were detected, 20 where they were not), stations with owl detections had significantly more old-growth conifers (t = 2.4; *P* = 0.02), more large sawtimber (t = 2.4; *P* = 0.02), less in pole stands (t = 3.0: *P* = 0.004), less sapling/shrub/forb habitat (t = 1.0; *P* = 0.03), and less grass/shrub/forb habitat (t = 2.6; *P* = 0.01).

Paz et al. (1979)

Surveys were done in 1978 and 1979, using the leapfrog method to cover a total of 468.6 miles of routes.

Results—Nineteen pairs were located, 11 in old growth; five pairs had young, of which three were in old growth. Seven pairs were found in mature stands, and two had young. One pair was found in a second-growth stand that resulted from fire (table G5).

Appendix G: Owl Abundance

Because no attempt was made to assure that survey routes were in large, extensive stands of similar-aged forest, or to assure that second-growth stands lacked old-growth inclusions (Paz, pers. comm.), no significance can be attached to the results of this study as evidence that spotted owls prefer either older or younger forests. This conclusion is supported by the fact that stand characteristics measured where owls were detected failed to show marked structural differences between old-growth/mature stands (data pooled) and second-growth stands.

Diller (1989)

From 31 May to 27 July 1989, observers sampled 129 miles of survey routes by vehicle and on foot, stopping every 0.3 mile to broadcast recorded calls of spotted owls for 10 minutes. Surveys were done in four general regions on Simpson Redwood Company lands in northwestern California. The Smith tract (about 29,000 acres) was primarily redwood-Douglas-fir forest, sometimes with an understory of tanoak or red alder. Logging began in the 1920s and continues today. The Klamath tract (about 100,000 acres) was mainly redwood-Douglas-fir forest, with tanoak and red alder common in the understory and several interspersed patches of grassland. Most old growth had been logged; remaining patches were generally smaller than 60 acres. Most stands in the tract were <50 years old. The Korbel tract (42,000 acres) was dominated by redwood and Douglas-fir forest, again commonly with an understory of tanoak and, less commonly, with red alder. Logging on the tract began more than 100 years ago; only scattered remnants of old growth remained. Stand ages ranged from 0 to 80 years. The Mad River segment (about 20,000 acres) of the Korbel tract was logged from the 1880s to the 1930s. After harvest, areas were burned in an attempt to produce pasture land. Logging of second growth began in 1979, and less than half remains. Ages of remaining stands ranged from 55 to 80 years. The Fortuna tract (about 10,000 acres) was primarily second-growth redwood and Douglas-fir. Stand ages ranged from 0 to 60 years. Habitat measures were taken from 1988 aerial photos, existing timber inventories, and various maps.

Follow-up visits were made during the daytime to as many nighttime locations as possible, in an effort to locate roost and nest sites and to determine possible pairing and breeding status.

Results—In addition to spotted owls located during surveys and follow-ups, others were located by spot calling in areas not surveyed. The study produced a total of 46 males, 29 mated pairs, and 20 young of the year (table G6). Fifteen reproductive pairs were confirmed; 57% of the nesting and roosting areas were in stands dominated by redwood and Douglas-fir. Hardwoods of various species were abundant in 48% of the nesting and roosting sites. Stand ages in nesting and roosting areas ranged from 30 to 100 years ($\bar{x}$ = 57 years). Stand height ranged from 40 to 160 feet, with a median of 101 feet. Canopy closure ranged from 50 to 90%, with a mean of 81%. Distances to old-growth stands ranged from 2 to 14 miles ($\bar{x}$ = 8.6 miles).

Pious (1989)

From 1 April to 1 September 1989, observers surveyed 857 miles of roads in second-growth coastal redwood and Douglas-fir forests in north-coastal California (fig. G6). A subset of 31 sites where owls were detected was chosen for further investigation seeking evidence of nesting, following the standard monitoring protocols used by the FS. Redwoods or Douglas-fir dominated all stands, with trees ranging in size to at least 4 feet in d.b.h.

Appendix G: Owl Abundance

Table G6—Summary of results from calling surveys for spotted owls in second-growth forests (mainly redwood and Douglas-fir) in northwestern California in 1989 (Diller 1989)

Tract	Miles surveyed	Owl responses	Responses per mile	Mean age of stands
Smith River	22.6	4	0.18	46.0
Klamath	64.8	7	0.11	41.0
Korbel and Fortuna	41.7	22	0.53	47.2

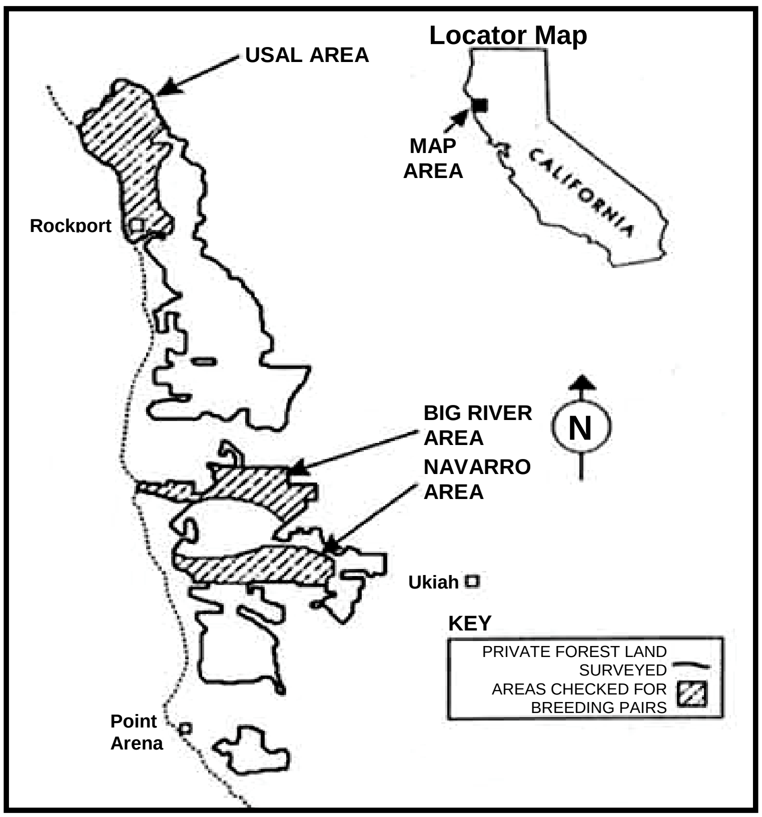

Figure G6—General study areas sampled by Pious (1989)

Results—Spotted owls were found in 90 sites in the study area and pairs were found at 51 sites; owls were detected at a rate of 0.06 per mile of road traveled. Stand ages were estimated from core samples of trees in the dominant overstory canopy. From data presented in appendix 5 of the report by Pious (1989), we summarized stand ages in relation to spotted owls breeding by geographic area. In 1989 showed a trend toward a higher mean age of stands in sites with nesting pairs ($\bar{x}$ = 80.9 years, SD = 33.0, n = 8) than in sites without them ($\bar{x}$ = 69.7 years, SD = 27.0, n = 21). The difference was not significant (t = 0.94; df = 27; 0.4 > P > 0.3). Results also showed an increasing percentage of nesting pairs in areas

Table G7—Mean stand ages in 3 geographic areas in coastal redwood and Douglas-fir forests of California in relation to the proportion of breeding pairs of spotted owls located (based on data from Pious 1989)

Geographic area	Stand age			Nesting pairs	
	Mean	SD	*n*	*n*	Percent
Usal	59.7	19.3	7	1	13
Big River	64.8	30.7	12	2	17
Navarro	91.6	23.2	10	5	50

with older stands (table G7). The mean age of stands in the Navarro area, which had a much higher percentage of nesting pairs than either of the other areas, was significantly different from that in the Big River area (t= 2.3; df = 20; 0.05> *P* > 0.02) and the Usal area (t = 2.9; df = 15; 0.05 > *P* > 0.02).

Bart and Forsman (unpubl.)

In this study, Bart and Forsman (unpubl.) compared the densities of spotted owls in areas dominated by clearcuts and young forest (50 to 80 years) with nearby areas where old-growth forest was more abundant (fig. G7). Twelve of these pairwise comparisons were made. The objective was to assess the effects of widespread clearcutting on spotted owl numbers, so areas were excluded where extensive selection cutting or partial burns had occurred. Data were summarized from several sources, including unpublished reports and direct communication with FS and BLM personnel. Second-growth study areas ranged in size from 5 to 277 square miles ($\bar{x}$ = 60.3 mi^2; SD = 83.1). Old-growth study areas ranged in size from 11 to 113 square miles ($\bar{x}$ = 57.0 mi^2; SD = 36.7). Nearly all study areas covered at least 8 square miles (the few exceptions are noted below), and all were surveyed at least three times in at least one year. Results were expressed as mean annual numbers of owl pairs and singles per 100 square miles.

Results—In study areas dominated by young forests, stands 50 to 80 years old covered from 33 to 92% of the landbase (x = 59.3%; SD = 18.1), stands 81 to 120 years old covered from 0 to 67% (x = 7.1%; SD = 19.4), and stands older than 160 years covered from 0 to 15% ($\bar{x}$ = 4.1%; SD = 5.2) (table G8). In old-growth study areas, stands 50 to 80 years old covered 0 to 39% of the total area ($\bar{x}$ = 6.1%; SD = 12.4). Stands 81 to 120 years old were missing from all but one site, which had 10% coverage by that age-class, and stands 160+ years old covered an average of 49.1% of the land (SD = 18.8; range 19 to 73%) (table G8).

Results indicated that forests <80 years old, regenerating from clearcut logging and lacking appreciable amounts of older forest in remnant patches, were poor habitat for spotted owls (table G8) (see appendix F for details on suitable owl habitat). The study did not provide enough data to address the question of habitat suitability in stands 81 to 120 years old. Pairs of spotted owls were documented in only 2 of the 12 second-growth study areas. One area included 15% mature age-class stands (81 to 120 years old), and 5% >160-year-old stands. The other area had 4% of its area in the >160-year class. The mean density of spotted owl pairs on the second-growth areas was 0.83/1 00 square miles (SD = 1.99). Old-growth study areas had a mean of 12.75 pairs per 100 square miles (SD = 11.3), and all old-growth areas had owl pairs (range = 2/100 square miles to 36/100 square miles).

Appendix G: Owl Abundance

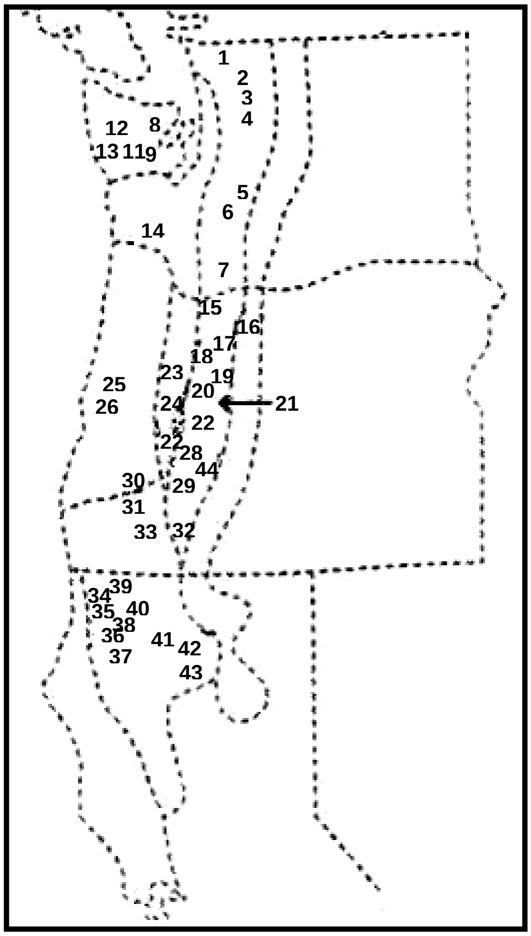

Figure G7—Approximate study areas of Bart and Forsman.

Discussion

Washington and Oregon

Data from Washington and Oregon are inadequate to determine the general ages when conifer forests begin to develop stand conditions suitable for spotted owls to breed. Not all studies directly compared both young and old forests, and even the set of all studies had relatively few survey routes in extensive stands of forests in the age group from about 80 to about 120 years. But the data suggest that this is the most likely period when forests "come of age" for spotted owls. Relatively young stands (20 to 60 years old), however, were generally unsuitable as owl habitat in Douglas-fir-hemlock forests in western Oregon and Washington.

Table G8—Characteristics of landscape-scale areas surveyed for spotted owls in Washington, Oregon, and northern California (study areas displayed in each row were matched in the same geographic region (data from Bart and Forman, unpubl.))

Study areas by age designation (see fig. G7)		Percentage of total area[a] by age-class[b]								Density[c]			
		Second-growth study sites				Old-growth study sites				Pairs/100 mi^2		Singles/100 mi^2	
		Total area	Age-class[d]			Total area	Age-class[d]						
Second Growth	Old growth	(mi^2)	50-80	81-120	160+	(mi^2)	50-80	81-120	160+	Second growth	Old growth	Second growth	Old growth
2	2	5	33	67	0	108	0	0	60	0	8	0	2
4	3	20	50	0	0	44	0	0	30	0	2	0	5
5	5	9	92	0	0	84	0	0	55	0	9	0	5
6	7	36	75	0	0	11	0	0	40	0	9	0	19
9	9	15	65	0	15	45	0	0	62	0	7	0	4
11	11	16	81	0	9	113	0	0	73	0	12	0	0
14	12	277	52	0	0	20	29	0	61	0	20	1	0
22	22	21	68	3	11	92	0	10	60	0	5	0	6
23	23	155	44	15	5	18	8	0	28	4	36		
25	30	29	36	0	5	63	1	0	19	0	5	10	2
33	33	18	65	0	4	69	35	0	29	6	34	0	1
42	42	122	50	0	0	17	15	0	72	0	6	0	6

[a] Values show total area in square miles for each study area. Total area is then subdivided by age-class, with square miles and percentage of each given

[b] Study areas were designated second growth or old growth by the preponderance of the respective age-classes in them, but all had some mixing of age-classes.

[c] Total densities of owl pairs for each study area are shown, irrespective of the mix of age-classes.

[d] Where rows sum to <100%, the remainder of the study area was in stands <50 years old.

Appendix G: Owl Abundance

In studies that used standardized methods to sample the relative abundance of spotted owls in a variety of habitats, comparing indices of abundance by forest age or stand condition is reasonable. For example, Postovit's (1979) results indicate that the owls are about eight times more abundant in predominantly old-growth forests than in predominantly younger stands at randomly selected locations on the Olympic Peninsula and in the Washington Cascades. Results from Forsman et al. (1977) suggest a ratio of about 7:1 between owl abundance in old and young forests in Oregon. Another Washington study (Hays et al. 1989) of 47 randomly selected transects indicated a ratio of 10:1 between the predominantly old stands on the Olympic Peninsula and in the western Cascades and the predominantly younger stands of southwestern Washington. The study by Bart and Forsman most clearly demonstrates the relation between forest age and abundance of spotted owls because they focused their studies in areas of known age that were regenerating from clearcuts.

Collectively, these surveys indicate a much lower incidence of owls in forests younger than about 80 years. This conclusion is generally supported by results from studies of habitat use in relation to availability (see appendix F). Most of those studies suggest a high affinity of spotted owls for older forests, although exceptions exist. Obviously, much remains to be learned about the range of suitable habitats for spotted owls.

For example, we know that spotted owls in at least some portions of Oregon and Washington occur in forests 50 to 80 years old with a history of logging, fire, or wind-throw going back to the late 1800s and early 1900s. These forests, however, typically are not extensive tracts of even-aged stands. Rather, most contain remnant trees and patches of older trees surviving from earlier stands. As part of our effort to learn as much about the owls as possible in the time available to prepare a conservation strategy, we visited many sites such as this in spotted owl locations in Washington, Oregon, and California during the fall of 1989. A strong impression emerged from those visits that stand age is probably not the best criterion for judging suitable owl habitat. Stand structure is clearly of overriding importance (see appendix F). Apparently, suitable structure develops frequently in very old forests, but the age when it begins to develop is still not well known.

On the other side of this issue, we find the evidence compelling that suitable owl habitat takes somewhere between 80 and 120 years to develop from clearcut stands, depending on site conditions, elevation, and so on. The study of Bart and Forsman (unpubl.) supports this conclusion particularly well. Relevant as well are the hundreds of square miles of forests younger than 60 years in southwestern Washington and northwestern Oregon that cannot support a self-sustaining population of owls. Otherwise, numbers should be increasing there, and our measures of relative abundance should reflect that increase. The occasional presence of spotted owls in these forests, however, indicates a low occupancy rate that may infrequently result in movement of owls between the Olympic Peninsula and the Washington Cascades.

Appendix G: Owl Abundance

California

Recent studies supported by the timber industry in northern coastal California suggest that conditions suitable for occupancy and breeding by spotted owls develop rapidly in the redwood forests of north coastal California. Extensive tracts of relatively young, second-growth redwood forests contain owls, several of which were found breeding in 1989. Although the implications of these studies are not yet fully understood, they strongly suggest that suitable and even superior spotted owl habitat can develop faster in coastal forests of redwood and mixed redwood and Douglas-fir than appears to be true in most of the owl's range. For example, even in some forests as young as 60 to 70 years old, we toured impressive stands with many trees 3 to 4 feet in d.b.h., multilayered canopies, and other structural attributes generally recognized as typical components of suitable owl habitat. These studies in California need to continue to document the extent to which spotted owls may be able to sustain a breeding population within second-growth forests in the coastal redwood belt.

Meanwhile, no evidence indicates that such early development of suitable habitat is typical in most other parts of the owl's range. To the contrary, available evidence indicates that it is not. Relative to the rest of the range of the spotted owl, coastal California redwood and Douglas-fir forests are probably anomalous. Conditions for timber growth there are apparently ideal—good soil conditions, high rainfall, relatively long growing season, coastal fog, and especially the stump-sprouting capability of redwoods, all of which combine to produce a unique situation among western conifer forests. In addition, spotted owl diets in this region are dominated by dusky-footed woodrats and brush rabbits, both of which are common in young, coastal forests in northern California (appendix J), but which are rare or absent in much of the owl's range in Washington and Oregon.

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H

Abundance of Spotted Owls in Relation to the Amount of Suitable Habitat

Introduction

Much observational information suggests that spotted owl densities decline as portions of the remaining unlogged forest are harvested, but few well-designed studies have specifically addressed this matter in a way that excludes alternative explanations. For example, Forsman et al. (1987) reviewed all available information on the status of spotted owls in Oregon through 1984, concluding that the owls are found primarily in older (200 years) forests that have not been logged, and that owl numbers are declining in areas subjected to considerable harvest of such older forests. Their conclusions can be challenged, however, because sampling effort was not proportional to the total areas of different forest types and ages. Nonetheless, their summary compiles a massive data base representing 15 years of field effort by many biologists. Here, we briefly summarize available studies with information on the relative abundance of owls in relation to the amount of unlogged forest remaining in the landscape.

Forsman et al. (1987)

Forsman et al. compare the status of owl pairs between 1976 and 1987 from sites where extensive logging during that period reduced the amount of remaining old-growth forest. Spotted owl numbers were well known in the region in the 1970s.

Results—The best-documented case is from private and public lands, in a checkerboard ownership pattern, within the Roseburg District of the BLM in Oregon. At 56 sites where owl pairs were located between 1976 and 1977, 11 no longer had owls in 1987, and 8 others were believed to be unoccupied, based on 1 or 2 years of negative survey results after timber harvest. This amounted to an estimated loss of 20 to 34% of the spotted owl sites as a result of logging activity from 1976 to 1987. This rate is probably higher than occurred on National Forest lands during the same period, because the checkerboard ownership pattern of BLM and private holdings tends to fragment the habitat more in western Oregon than elsewhere.

Forsman (pers. comm.) also summarized the proportlon of all known sites where owls were located from 1969 to 1984 in logged and unlogged areas in Oregon. Although his summary was based on surveys unweighted by forest type and age-class, extensive effort by numerous observers has gone into searching for owls in a large variety of forest conditions in the State during the past decade or more. We are therefore impressed that only 2.1% of all known spotted owl sites in Oregon have been found in logged areas and only 14.7% of known sites were found in forests <200 years old.

Appendix H: Owl Abundance and Habitat

O'Halloran (1989) and Simon-Jackson (1989)

Using standard protocols, field biologists surveyed for owls in random sample areas (RSAs) and Spotted Owl Habitat Areas (SOHAs) in 1988 and 1989. Because RSAs were established as 1000-acre circles centered on points randomly selected throughout the National Forests of both Regions, results from the RSA surveys are well suited to test the null hypothesis that the occurrence of owls is not related to the amount of suitable habitat.

Results—In all 12 comparisons between RSAs with <500 acres of suitable habitat and RSAs with >500 acres of suitable habitat, the percentage of occupancy was higher in RSAs with more suitable habitat (table H1). Only two of the data sets were fully independent, however, so a test (for example, sign test) of the statistical significance of this result is inappropriate. The mean acreage of suitable habitat in occupied RSAS was, however, significantly greater than that in unoccupied RSAs in three of four comparisons (Region 5,1988; Region 6,1988 and 1989—table H2). In the fourth comparison (Region 5, 1989), the mean was greater in occupied RSAs but not significantly so.

Table H1—Occupancy rates in relation to the amount of suitable spotted owl habitat in random sample areas (RSAs)[a] in the FS monitoring program of Region 5 (Pacific Southwest Region) (Simon-Jackson 1989) and Region 6 (Pacific Northwest Region) (O'Halloran 1989)

	RSAs with <500 acres of suitable habitat		RSAs with >500 acres of suitable habitat	
	Region 5	Region 6	Region 5	Region 6
Reserved and nonreserved areas combined				
1988 Number RSAs sampled	83	130	21	54
RSAs with pairs or singles	40%	38%	81%	76%
RSAs with pairs only	16%	13%	52%	22%
1989 Number of RSAs sampled	93	91	42	48
RSAs with pairs or singles	52%	43%	57%	73%
RSAs with pairs only	16%	23%	29%	29%
Nonreserved areas only				
1988 Number RSAs sampled	66	86	15	26
RSAs with pairs or singles	45%	43%	80%	92%
RSAs with pairs only	17%	14%	47%	19%
1989 Number of RSAs sampled	54	58	17	25
RSAs with pairs or singles	65%	41%	71%	68%
RSAs with pairs only	20%	22%	41%	32%
Reserved areas only				
1988 Number RSAs sampled	17	44	6	28
RSAs with pairs or singles	18%	30%	83%	61%
RSAs with pairs only	12%	11%	67%	25%
1989 Number of RSAs sampled	39	33	25	23
RSAs with pairs or singles	33%	45%	48%	78%
RSAs with pairs only	10%	24%	20%	26%

[a] RSAs are 1000-acre circles with center points selected randomly from within National Forest boundaries. Points drawn from lake surfaces were excluded.

Table H2—Comparisons of mean acreages of suitable habitat in the 1000-acre circles comprising random sample areas (RSAs) occupied and not occupied by spotted owls in Regions 5 and 6 in 1988 and 1989 (our analyses, based on O'Halloran 1989, and Simon-Jackson 1989)

		Occupied RSAs			Unoccupied RSAs				
Location	Year	No. sites	Mean acres	SD	No. sites	Mean acres	SD	*t*-value	P
Region 5	1988	50	397	272	54	161	211	4.93	<0.00
	1989	72	394	262	63	356	274	-0.84	0.40
Region 6	1988	91	475	259	93	246	237	-6.25	<0.00
	1989	74	485	251	110	274	254	-5.58	<0.00

Table H3—Percentage cutover in 7 plot sizes centered on 30 spotted owl nest sites and 30 randomly selected points in the Cascade Range of western Oregon (Ripple at al. unpubl.)

Plot size		Percentage cutover around nest sites				Percentage cutover around random sites				
Acres	Miles radius	Mean	Min	Max	SD	Mean	Min	Max	SD	*P*-value
642	0.56	21.8	0	49	11.8	36.8	0	85	20.2	0.0008
1087	0.75	23.7	0	52	11.9	36.5	3	75	17.7	0.0016
1531	0.87	23.6	3	53	11.3	36.7	5	72	15.7	0.0004
1976	1.00	24.4	3	55	11.1	37.5	10	74	15.3	0.0003
2421	1.10	24.9	3	58	11.1	38.4	13	73	14.5	0.0002
4510	1.50	26.4	6	55	9.9	39.2	14	74	13.5	0.0001
8862	2.10	35.0	21	60	8.7	42.7	22	78	13.2	0.0101

Similarly, our analysis of the data for RSAs, using logistic regression models, indicated that percentage of occupancy by spotted owls increased significantly with an increasing amount of suitable habitat in Region 5 in 1988 (but not in 1989) and in Region 6 in both years (appendix K).

Logistic regression models using the SOHA data indicated that the percentage of owl occupancy increased significantly with an increasing amount of suitable habitat within 2.1 miles of SOHA centers in Region 6 in 1989. Such a relation was not found between owl occupancy and the amount of suitable habitat within 1.5 miles of SOHA centers in Region 5 in 1989.

Ripple et al.

Using dot grids on orthophoto quadrangles, Ripple et al. (unpubl.) estimated percentages of the landscape that were "cutover" at 30 nest sites, and at 30 matched sites randomly selected in the same general areas in the Cascade Range of western Oregon. Cutover was defined as "all areas not consisting of mature or old-growth forests (that is, harvested units, stands less than 80 years old, and water bodies)." Estimates were made for seven circular plot sizes (table H3) centered at nest trees and at randomly selected points.

Appendix H: Owl Abundance and Habitat

Table H4—Pairs of spotted owls per 100 square miles in relation to the proportion of suitable habitat (forests 160+ years old) in various large blocks (mean of 59 square miles) of habitat distributed widely throughout Washington, Oregon, and northern California (see fig. G7 in appendix G) [a]

	Percentage of areas in suitable habitat				
Region	0-20	21-40	41-60	61-80	81-100
Washington Cascades					
Pairs/100 mi^2	0	5	7	11	
Number of sites	5	8	13	3	0
Olympic Peninsula					
Pairs/100 mi^2	1	4	5	8	15
Number of sites	8	5	8	5	5
N. Oregon Cascades					
Pairs/100 mi^2	3	10	10	17	35
Number of sites	1	4	8	10	1
Willamette					
Pairs/100 mi^2	8	36			
Number of sites	5	3	0	0	0
S. Oregon Cascades					
Pairs/100 mi^2	10	12	12	31	21
Number of sites	1	5	2	3	3
Oregon Klamath					
Pairs/100 mi^2	6	16			
Number of sites	1	4	0	0	0
Willow Creek, CA					
Pairs/100 mi^2	9	30	45		
Number of sites	1	6	5	0	0

[a] Data are from study by Ban and Forsman (unpubl.).

Results—For each plot size, the mean percentage of cutover area at random sites was significantly greater than that at the nest sites (t-tests: $P < 0.01$ in all cases and $P < 0.003$ in six of the seven cases) (table H3).

Bart and Forsman

Bart and Forsman (unpubl.) summarized existing data in publications and reports on spotted owls and in FS and BLM files to determine owl densities in more than 40 large blocks of landscape ($\bar{x}$ = 59 mi^2), widely distributed throughout Washington, Oregon, and northern California (see fig. G7, appendix G). Estimates of density were based on repeated visits (minimum of three but most blocks were surveyed more often) to each block by agency and private personnel. Data for most blocks came only from visits in 1989, and blocks were included in the analysis only if the biologists responsible for surveys there expressed a high degree of confidence in the thoroughness of their surveys.

Results—An increasing trend in owl densities is clearly shown with increasing proportion of the landscape providing suitable owl habitat, as well as regional differences in densities in relation to available suitable habitat (table H4). For example, estimated densities in the Willamette and Willow Creek areas considerably exceed those for other areas with 21 to 40% of the area in suitable habitat. Whether or not packing (see appendix N) is manifested in these areas is uncertain. A demographic study in the Willow Creek area of northwestern California indicates that a large and increasing number of replacements of birds lost from that area are adults from outside the study area (Franklin and Noon, pers. comm.). Normally, in a stable population, we expect most replacements to be by subadult birds.

Conclusions

Although each of these studies alone would not provide a strong basis for evaluating the relation between the amount of old-growth forest in a given landscape and the relative abundance of spotted owls there, coincidence is unlikely to account for the general pattern. In considering the collective results of these studies, therefore, we conclude that removal of old-growth forests generally results in a decrease in the abundance of spotted owls. We know of no study that has reached an opposite conclusion.

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I

Home-Range Sizes and Characteristics

Introduction

In this summary of home-range information, we followed several conventions in an effort to make comparisons among studies as similar as possible. First, we used only 100% minimum-convex-polygon (MCP) estimates of home-range size for individual owls because that was the only measure consistently used in all studies. This method delineates a convex polygon that connects the outermost points where an animal was observed, and the area within the polygon is calculated. Second, to calculate pair home-range sizes, we used only home-range data from pairs that were tracked for most of one annual cycle so that we could be sure the tracking period included movements during the breeding season (1 March to 30 August), and during the non-breeding season (1 September to 28 February). Third, if pairs were tracked for 2 years or more, we treated the data from each year separately. Each year's data for owls in this category is referred to as an annual pair home range. Fourth, we used the median (as opposed to the mean) home-range size for pairs in each geographic region, because we were concerned that a few very large or very small home ranges might result in a mean value that was not typical of most owls in a given area. The median is the middle value in a distribution, with half the sample larger and half smaller than the median. Fifth, we used the combined home ranges used by pairs of owls as the best measure of the area and habitat required to sustain pairs. Owl pair home ranges were determined by overlaying the male and female ranges and summing the area shared by the pair with the exclusive areas of the home ranges of each.

Readers who may compare estimates of home-range sizes and composition in this report with those from preliminary reports of the same studies should be aware that many data sets were enhanced through personal communications with researchers in March 1990. Values reported in tables I1 and I2 are, therefore, the most up-to-date estimates available. We have also excluded large bodies of water, such as reservoirs, from home-range areas.

All available information on home-range characteristics was based on radio-telemetry studies. Researchers usually used back-pack transmitters weighing 19 to 23 grams. Comparisons were made of survival and reproduction of radio-marked, adult spotted owls in California (Paton et al. 1990) and in Washington and Oregon (Foster et al. 1990) with survival and reproduction of color-banded adults in the same regions and periods. Results indicated that backpack radio transmitters may negatively affect the reproduction, and in some areas, the survival of radio-marked owls. Because we have no evidence to the contrary, however, we assume that radio transmitters have no significant effect on habitat selection or home-range use by the owls.

Appendix I: Home Range

Table I1—Median annual home-range areas (in acres) of spotted owl pairs in different study areas and physiographic provinces [a]

State Location Site	*n*	Forest type [b]	Median	Range Min	Range Max	Sources [c]
California						
Klamath Mountains						
Ukonom	9	MC	3,314	2,058	7,823	1
Mad River	12	MC	2,975	1,803	4,685	1
Willow Creek	2	MC	1,692	1,258	2,128	2
Oregon						
South Coast						
Chetco	4	MH	5,614	5,327	8,197	1
Klamath Mountains						
South Umpqua	3	MC	1,411	1,035	1,504	3
Cow Creek	6	MC	4,106	2,499	7,494	3
Coast Ranges						
Tyee	5	DF/HEM	3,387	1,880	8,272	3
Peterson	4	DF/HEM	6,318	3,483	10,189	3
Eugene BLM	4	DF/HEM	6,390	3,715	8,180	4
Other [d]	4	DF/HEM	4,183	2,849	9,748	5
Kellogg [e]	5	MC	4,072	1,618	6,281	3
Western Cascades	11	DF/HEM	2,955	1,443	9,758	6,7
Washington						
Western Cascades	13	DF/HEM	6,308	1,927	30,961	8,9,10
Olympic Peninsula	10	HEM/DF	9,930	4,497	27,309	9,11

[a] Pair ranges were calculated by delineating 100% MCPs: total = exclusive area of male + exclusive area of female + the area of overlap shared by the two sexes.

[b] MC = mixed-conifer, MH = mixed-conifer/evergreen, DF/HEM Douglas-fir, western hemlock, HEM/DF = mostly western hemlock with Douglas-fir intermixed.

[c] 1 = Paton et al. (1990), 2 = Solis (1983), 3 = Carey (pers. comm.), 4 = Thrailkill and Meslow (pers. comm.), 5 = Carey et al. (1990), 6 = Forsman and Meslow (1985), 7 = Miller (pers. comm.), 8 = Allen et al. (1989), 9 = Hays et al, (1989), 10 = Hamer (pers. comm.), 11 = Forsman (pers. comm.).

[d] Includes four sites in the southern coast Ranges near Roseburg.

[e] This was a relatively dry area bordering the Umpqua River Valley, characterized by mixed-conifer forest more typical of the Klamath Mountains Province than the coast Ranges.

Appendix I: Home Range

Table I2—Median amounts of old-growth and mature forest (in acres) in annual pair home ranges of spotted owls, by State and physiographic province

State / Location / Site	*n*	Forest type[a]	Median	Range Min	Range Max	Sources[b]
California						
Klamath Mountains						
Ukonom	9	MC	2,484	1,030	5,654	1,2
Mad River	12	MC	1,365	835	1,953	1,2
Six Rivers NF	2	MC	800	367	1,233	3
Oregon						
Klamath Mountains						
South Umpqua	3	MC	615	563	768	4
Cow Creek	6	MC	1,549	1,450	1,983	4
Coast Ranges						
Tyee	5	DF/HEM	2,031	1,645	3,984	4
Peterson	4	DF/HEM	2,609	1,284	3,196	4
Eugene BLM	4	DF/HEM	1,783	799	3,580	5
Other[c]	4	DF/HEM	2,375	1,795	2,625	6
Kellogg[d]	5	MC	1,018	697	1,983	4
West Slope Cascades	9	DF/HEM	1,796	1,050	3,786	7,8
Washington						
West Slope Cascades	13	DF/HEM	3,281	1,927	20,561	9,10,11
Olympic Peninsula	7	HEM/DF	4,579	2,787	8,448	12

[a] MC = mixed-conifer, DF/HEM = Douglas-fir, western hemlock. HEM/DF = mostly western hemlock with Douglas-fir intermixed.

[b] 1 = Paton et al. (1990), 2 = Paton (pers. comm.), 3 = Solis (1983), 4 = Carey (pers. comm.), 5 = Thrailkill and Meslow (pers. comm.), 6 = Carey et al. (1990), 7= Forsman and Meslow (1985), 5 = Miller (pers. comm.), 9 = Allen et al. (1989), 10 = Hays et al. (1989), 11 = Hamer (pers. comm.), 12 = Forsman (pers. comm.).

[c] Includes four sites in the southern Coast Range near Roseburg.

[d] This was a relatively dry area bordering the Umpqua River Valley, characterized by mixed-conifer forest more typical of the Klamath Mountains Province than the Coast Ranges.

Home-Range Studies by State

Washington—Five studies of home-range characteristics of spotted owls in Washington have been reported (Allen et al. 1989; Egtvedt and Manuwal 1988: Forsman, pers. comm.; Hamer, pers. comm.; Hamer et al. 1989; Hays et al. 1989). The studies of Allen et al. (1989) and Hays et al. (1989) were done concurrently from 1982 to 1986 by the Washington Department of Wildlife (WDW), and followed a total of 32 owls located in various areas of the Washington Cascades and the Olympic Peninsula. We had adequate samples to estimate annual pair home ranges of five owl pairs in the Cascades and two pairs on the Olympic Peninsula (table I1).

Appendix I: Home Range

Forsman (pers. comm.) followed 22 owls (10 pairs, 2 singles) on the west side of the Olympic Peninsula from April 1987 to September 1989. Eight of the 10 pairs were tracked for at least 9 months and were considered adequate for estimating annual pair home ranges (table I1). Hamer (pers. comm.) reported eight annual pair ranges on the west slope of the North Cascades near Baker Lake. Egtevedt and Manuwal (1988) reported a home range of 8868 acres for one owl on the Cedar River Watershed, but sample size was inadequate for determining the annual home range. The amount of overlap (47%) between home ranges of adjacent pairs was reported for only two neighboring pairs in Washington (Hays et al. 1989).

Some of the individuals in the above studies had winter and summer home ranges that were largely nonoverlapping. To estimate the total home-range size for those individuals, the MCP areas of the winter and summer home ranges were summed. Median owl-pair home-range sizes in Washington were 6308 acres on the west slope of the Cascades, and 9930 acres on the Olympic Peninsula (table I1).

Oregon—Nine studies of spotted owl home-range characteristics have been reported in Oregon (Carey, pers. comm.; Carey et al. 1990: Forsman 1980, 1981; Forsman et al. 1984; Irwin, pers. comm.: Miller, pers. comm.; Miller and Meslow 1989; Paton et al. 1990; Thrailkill and Meslow 1990; Wagner and Meslow 1989). The two studies by Irwin and by Wagner and Meslow are still in progress.

Median, annual pair home-range size varied considerably, both within and among geographic provinces (table I1). Carey (pers. comm.) suggested that pairs in his study had smaller home ranges in areas where old growth occurred in a more clumped (contiguous) distribution. Forsman (1981) and Thrailkill and Meslow (1990) suggested a similar relation between home-range size and distribution of older forest.

Most spotted owls in Oregon had overlapping winter and summer home ranges. A single exception was reported by Miller (pers. comm.), who observed a female with separate winter and summer home ranges. Information on overlap between home ranges of adjacent pairs in Oregon was reported in only two studies. Carey (pers. comm.) found that the mean overlap of home ranges of neighboring pairs in five different areas near Roseburg ranged from 1 to 26%. Miller (pers. comm.) reported a mean overlap of 18% for three neighboring pairs.

Northwestern California—Within the range of the northern spotted owl in California, four studies of home ranges of spotted owls have been reported (Kerns 1989, Paton et al. 1990, Sisco and Guttiérez 1984, Solis 1983). Sisco and Gutiérrez (1984) and Solis (1983) studied owls in the same area of Six Rivers National Forest. Because of small sample sizes, we report pair home ranges for only two of the pairs they followed (table I1) Paton et al. (1990) reported 21 annual pair ranges from two study areas in the Klamath Mountains. On those study areas, median annual pair ranges were about 3000 acres, with a range of 1803 to 7823 acres (table I1). Kerns (1989) reported on movements of eight owls but did not analyze home-range size.

Appendix I: Home Range

Summary of Home-Range Studies

We could not detect any consistent patterns between home-range size relative to forest type or geographic region, except that home ranges in Washington were very large compared to most areas farther south (table I1). Median pair home ranges of 3000 to 5000 acres seemed typical of most areas, with the smallest median (1411 acres) reported for an area with a clumped distribution of older forest at the northern edge of the Klamath Mountains (Carey, pers. comm.).

In Oregon, areas with median pair ranges greater than 5000 acres were typically in heavily logged areas where the proportion of the landbase covered by older forests was low (Carey, pers. comm.; Forsman and Meslow 1985: Paton et al. 1990; Thrailkill and Meslow 1990). This relationship suggests that a reduction in the proportional coverage of suitable foraging habitat causes spotted owls to increase the size of their home ranges to encompass additional foraging habitat (Carey 1985, Forsman et al. 1984, Thrailkill and Meslow 1990).

Although the data are not presented in table I1, we also consider a study by Forsman and Meslow (1985) to be significant. They reported on three pairs of owls tracked for a period of 3 to 4 months in a heavily logged portion of the Oregon Coast Range in 1980. Even though the tracking period was inadequate to determine the annual pair range, the median home range for the three pairs (8343 acres) was much larger than reported for areas with a relatively high proportion of coverage by old forests, such as the western Oregon Cascades and the Tyee study area in the Oregon Coast Ranges (table I1).

Another factor apparent from the data was that the home-range size of both individuals and pairs varied considerably from year to year (Paton et al. 1990, Thrailkill and Meslow 1990). Dramatic differences in home-range size and shape were sometimes associated with changes in individuals occupying a site (Miller, pers. comm.; Paton et al. 1990). We cannot segregate such changes from yearly variation, however.

Amount of Old Forest Within Annual Pair Home Ranges

The amount of older forest within the annual home ranges of owl pairs may be a good indicator of the amount of that type of habitat needed to sustain the pair (see appendix F for a discussion of habitat requirements). Median amounts of old-growth and mature forest within annual pair home ranges in mixed-conifer forests ranged from 615 to 2484 acres (table I2). The smallest median value (615 acres) was from a study area where the remaining old forests were clumped rather than fragmented (Carey, pers. comm.).

In forests of Douglas-fir and western hemlock in western Oregon, median acreages of older forest in annual pair ranges were between 2031 and 2609 acres (table I2). Median areas of old forest in pair ranges in Washington were 4579 acres on the Olympic Peninsula and 3281 acres on the west slope of the Cascade Range (table I2).

Kerns (1989) studied eight owls in an area with <1% old-growth forest. As discussed in appendix F, however, the young redwood stands in his study area had structural attributes somewhat similar to old-growth forests in other forest types within the range of the owl. Kerns did not have enough locations to calculate amounts of habitat within annual home ranges.

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Discussion

The considerable effort expended in recent years to determine home-range size and composition for spotted owls was largely a response to previous owl management plans that emphasized habitat-management units for single pairs (SOHAs), rather than large groups of pairs that would occupy large HCAs, as proposed in this conservation strategy. One of the primary pieces of information needed to develop those plans was information on the amount and kinds of habitat required to sustain single pairs. In our proposed strategy, the need to manage single pairs is largely eliminated in the long term, except in a few problem areas where owl numbers are particularly low, or where natural fragmentation of the habitat makes management of large clusters of pairs impossible.

In our plan, the primary goal is to ensure that areas delineated as HCAs are large enough to contain at least 20 pairs of owls in the long term. This goal requires an estimate of future populations in the HCAs.

Existing knowledge of local owl density was considered our best guide for determining HCA sizes. Information on owl density was available from several study areas in California, Oregon, and Washington. Estimates were calculated only for relatively large study areas (>30 square miles) where owl densities were determined by systematic surveys of the entire area. Density was expressed as pair numbers or territories per square mile.

In the absence of good information on owl density, we used home-range data to guide us in estimating the sizes of HCAs needed in various parts of the owl's geographic range. These estimates were made independently from those based on information on actual or probable owl densities in delineated HCAs. We used the median home-range area from data in sites most like those under consideration. Because we know that neighboring pair home ranges overlap to some extent, we allowed for 25% overlap of the home ranges in HCAs. This number could be debated, but we consider it to be reasonable, based on the available data.

For a 20-pair HCA, then, the total size needed was estimated using the formula

HCA size = 20 pairs x the median annual pair home-range size x 0.75.

This estimate was then compared with the one independently derived from known owl densities in the region under consideration, when these values differed considerably, the areas were re-examined to resolve the discrepancy (see appendices M and 0 for more details on this procedure). If further adjustments were made in HCAs to assure at least 20 pairs, they were based on such conditions as inclusions of significant areas of unsuitable habitat, high elevation, extensive fragmentation, and checkerboard ownership.

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